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THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Leonel Yanez MARTINEZ et al.

Serial No. 10/613,433

Group Art Unit: 2831

Filed: July 3, 2003

Examiner: William Mayo II

Title: **DRY WATER RESISTANT COAXIAL CABLE AND METHOD OF MANUFACTURE THEREOF**

APPELLANTS' REPLY BRIEF UNDER 37 C.F.R. §41.41

Docket No. MX/JFC-Serv-001

Assistant Commissioner for Patents
Washington D.C. 20231

Sir:

The following is Appellants' Reply Brief pursuant to 37 C.F.R. §41.41 in response to Examiner's Answer. A one month extension of time is included with this Brief.

I. BACKGROUND

This appeal involves a dry, water resistant, coaxial cable for use in **cable TV** for signal transmission. In order to connect coaxial cables to transmission or reception equipment, it is necessary to prepare cable and then seal the connectors to prevent water penetration. The problem is that due to poor sealing, inadequate cable installation results. Current methods to prevent water penetration use fillers and oil dispersed water insoluble materials and stabilizers based on glycol, ester acetate, ethylene glycol ester or ethylene glycol ester acetate.

The Appellants have developed a technique through a design of dry cable, i.e., without the use of filler, but incorporates the water penetration prevention element which permits to prepare and connect coaxial cable without using solvents and other cleaning

elements.

On March 21, 2007, the present claims of the pending patent application filed on September 18, 2008, issued as EP 1457996 (attached). This was discussed in the previous responses and appeal brief.

On July 15, 2008, The Board of Appeals denied the Appellants' appeal and stated that the Examiner has established obviousness of Claims 11-27 and that the cited prior art by the Examiner, e.g., Chan, U.S. 5,486,648 clearly describes all of the limitation set forth in the claim including the adhesive in the first polymer layer and that Goehlich, U.S. 6,784,371 are merely cumulative to teachings in Chan et al. The Board also indicated that Claim 22 which recited specific thickness in the Appellants' application was taught by Belli, U.S. 6,455,769 and would involve only routine skill in the art.

On September 18, 2008, the Appellants filed a new set of claims in the patent application. The new set of claims have been **substantially narrowed** and recited limitation "consisting of."

The Examiner continued to reject the substantially narrowed new set of Appellants' claims over the same prior art, Chan, U.S. 5,486,648, Goehlich, U.S. 6,784,371 and Belli, U.S. 6,455,769. Again, Appellants appealed the rejection of the pending new set of claims with the limitation "consisting of" on November 11, 2009. The Examiner Answer issued on February 18, 2010.

It is submitted that an understanding of the cited references and of Appellants' invention is essential to correct the resolution of the instant application.

A newly cited prior art was cited in the Final rejection, Hughey, US 5043538. MPEP§706.07 (a) Improper Final Rejection and MPEP §904 et seq. rejection on prior art not of record. Another newly cited prior art is Midner US 3,795,640 in the Examiner Answer. Appellants will petition these newly cited art together with the objected claims.

II. DISCUSSION

Claim 68 is the only independent claim and reads as follows:

Dry, water resistant coaxial cable **consisting** of :

a metal core conductor element, a dielectric element around the core conductor based on three layers,

the *first layer* being applied onto the conductor as a uniformly thick film based on low density polyethylene mixed with a ***vinyl or acrylic adhesive***,

the *second layer* being based on an expanded polyethylene mix **consisting** of low density polyethylene or mixture of low, medium and high density polyethylenes and a swelling agent selected from azodicarbonamide, p-toluene sulphonylhydrazide, or 5-phenyltetrazol, and

optionally a *reinforcement layer* of the same characteristics as the first layer;

wherein it has a *second external conductor* element formed by a tape made of an aluminum or copper alloy or combined with other elements and surrounding said conductor **consisting** of a water penetration protective element keeping it dry and based on one or several swellable *fibers or tapes* formed by polyester threads or other swellable fibers; and

the *protective cover* based on low, medium, high density polyethylene or a combination thereof.

The present application discloses a dry, water resistant coaxial cable, the embodiment of which are illustrated as Figures 1 and 2 below:

FIG. 2

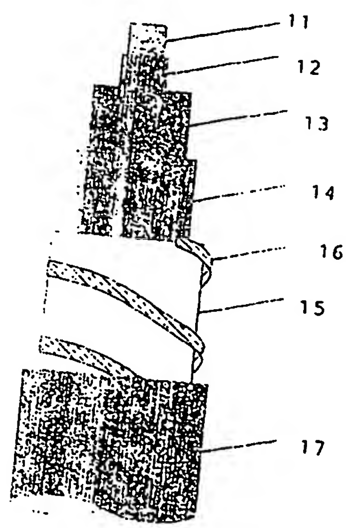
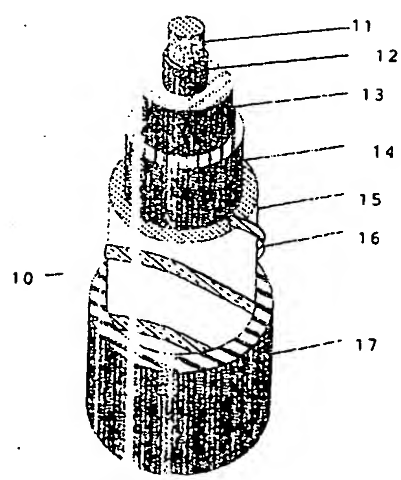


FIG. 1



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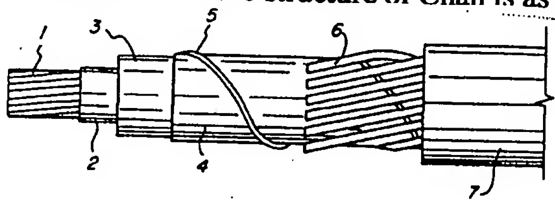
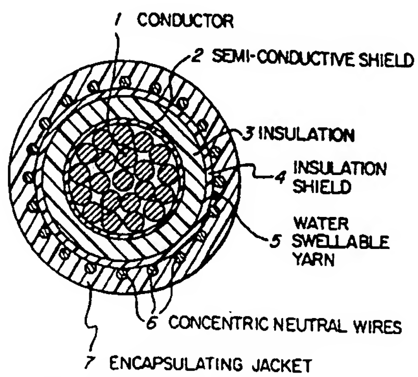
Chan et al., U.S. 5,486,648 discloses a power cable comprising conductor (1);semiconductive shield (**2**); insulation layer (**3**);insulation shield (**4**);water swellable yarn (5);concentric neutral wires(CNW) (**6**) encapsulating jacket (**7**). The embodiments of CNW comprises at least **8 embodiments**.

One embodiment of the structure of Chan is as follows:





Belli et al., U.S. 6,455,769 discloses an **electrical** cable which **uses fillers** which the present *invention avoids. The cable comprises a conductor* (1), *inner semiconductor* (2), insulating layer (3) semiconductive layer (4), expanded layer (5), metal shield (6) and outer sheath (7). Belli discloses "expanded layer" which has a degree of expansion between 5% and 500%, preferably from 10% to 200%. This "elemental property" which is critical to Belli is **not** encompassed by the Appellants' cable. Belli lists an **infinite** list of expanded layers. The Examples employed crosslinked polymers for the dielectric. The electrical cable structure of Belli is as follows:

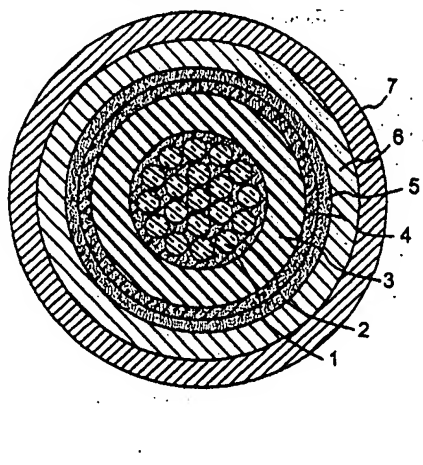


FIG. 1

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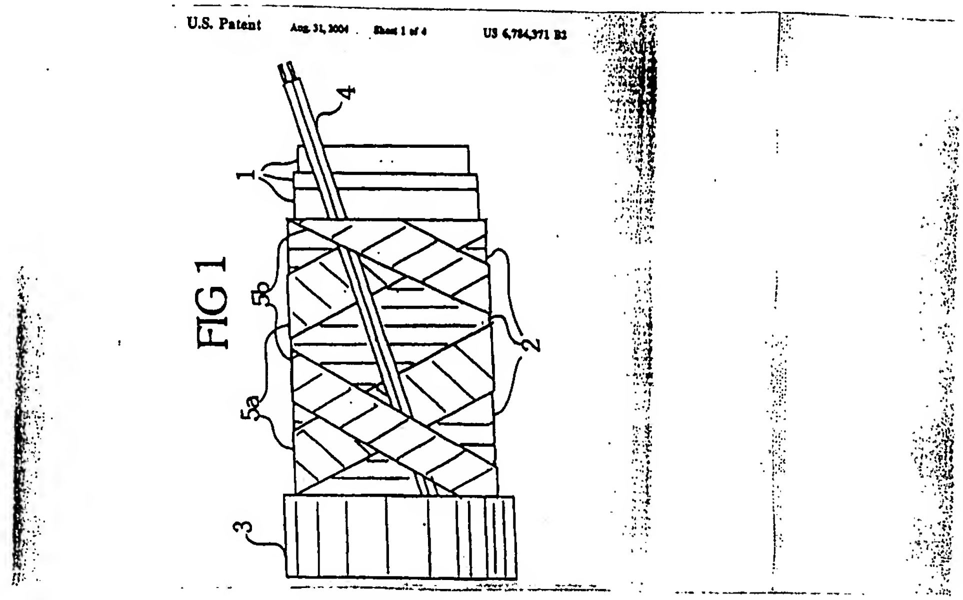
Goehlich, U.S. 6,784,371 discloses a cable comprising a cable core (1); an inner sheath (2) made of plastic or metal; sensor (4); outer cable sheath (3) made of plastic; and a structured material (4), i.e., sputtered adhesive /sealing material, tape/sputtered adhesive. An **"infinite list" of structured material** was disclosed in Goehlich.

One of the 4 embodiments (see Fig. 1-4) of the cable structure of Goehlich is as follows:



Chan et al. is the reference on which the Examiner relied for its conclusion that instant patent application is obvious because it would have been obvious to modify the concentric neutral wires (CNW) of Chan with the swelling agents of Belli et al. and the adhesive of Goehlich et al. and arrive at the presently claimed invention.

A. *Cited Prior art*

As discussed above, Appellants' invention is directed to dry, water resistant, coaxial cable for use in **cable TV** for signal transmission. The cable of Chan is directed to **ground power and electrical cables**. The cable of Belli is directed to **electrical cables**. Goehlich is directed to **power cable**, copper telecom cable or fibre optical cable. Hughey is directed to **power cable**.

Unlike Appellants, Chan et al., Belli et al. and Goehlich et al. does **not involve communication cables**. Rather, all of the cited prior art are directed to **power cables**. Power cables are long, cylindrical symmetric structures with a dielectric which operates at relatively high electrical stress. See Chan et al., Background of Invention.

The present invention which is directed to coaxial cable for use in **cable TV** for signal transmission. Coaxial cable is used as a transmission line for radio frequency signals, in applications such as connecting radio transmitters and receivers with their antennas, computer network (Internet) connections, and distributing cable television signals. One advantage of coaxial cables over other types of transmission line is that the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors. *This allows coaxial cable runs to be installed next to metal objects* such as gutters without the power losses that occur in other transmission lines, and provides protection of the signal from external electromagnetic interference. Coaxial cable differs from other shielded cable used for carrying lower frequency signals such as audio signals, in that the dimensions of the cable are controlled to produce a repeatable and predictable conductor spacing needed to function efficiently as a radio frequency transmission line.

The presently claimed invention is directed to **communication cables**, i.e., **cable TV** networks are designed taking into account the use of coaxial cables for signal *transmission from the generation building to the subscribers. Said coaxial cables* are classified in trunk, distribution and drop cables, and are usually made up of a core conductor, a dielectric insulation, and external conductor and a protective cover. See Appellants' Field of Invention paragraph 0002. Moreover, the cable can be used for trunk or **distribution cable in transmission networks for radio frequency signals, specifically for analog or digital television transmission signals** as well as energy signals for activating control peripheral equipment. It can also be used for Internet signal transmission, data transmission, cellular phone, etc. See Appellants' Description of Invention paragraph *0016*.

B. CNW of Chan et al. compared to external conductor of present invention

The Examiner *alleged that the concentric neutral wires (CNW) is equivalent to the* external conductor of the presently claimed cable. Appellants disagree. It is submitted that in Chan etal., as shown in the Figure above, the concentric neutral wires (CNW) are **not solid, i.e., not continuous** (See Figures 1-8 of Chan). In contrast, the external conductor of the present invention is **solid all the way around**. The external conductor supports the electric field. This property **can not** be performed by the CNW of Chan

because the wires **are stranded or not connected**. It is submitted that a non-continuous path will not provide the magnetic and electric path. It has to be a continuous conductor. The current *will not flow because conductors are separate. The CNW will not work* in a signal application as claimed in the present application.

The external conductor of the present invention has different functions. First is to provide to the coaxial cable a second conductor; Second, the second conductor is a shield against electromagnetic fields because it completely encloses the inner conductor; and Third, the second conductor is completely hermetical (airtight) and provides protection against humidity. It is submitted that the CNW of Chan et al. does not provide any of these functions.

Finally, the outer shield has to be a good conductor to maintain the magnetic and electric field. If CNW was employed in the presently claimed invention, the impedance (ratio of the voltage to current in the cable) will be low, i.e., the CNW will impede the flow of current.

C. Crosslinked polyethylene (XLPE) is not equivalent to Low density polyethylene (LDPE) of the present invention

For the semi-conductor shield layer (2) of Chan required polymeric compounds such as **crosslinked polyolefin** (XLPE),[1] ethylene propylene **rubber** (EPR) or ethylene vinyl acetate (EVA). Note col. 4, line 26 of Chan. In contrast, the structure of Appellants' cable required low density polyethylene (LDPE)[2] These materials are different in function and properties. It is submitted that crosslinked polyolefin (XLPE), EPR or EVA of Chan are not functionally equivalent to *LDPE of the presently claimed* invention.

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[1] XLPE a *medium- to high-density polyethylene containing cross-link bonds introduced into the* polymer structure, changing the thermoplastic into an elastomer. The high-temperature properties of the polymer are improved, its flow is reduced and its chemical resistance is enhanced. In polymer chemistry, when a synthetic polymer is said to be "crosslinked", it usually means that the entire bulk of the polymer has been exposed to the crosslinking method. See www.wikipedia.org/wiki/XLPE.

[2] LDPE is defined by a density range of 0.910-0.940 g/cm^3 LDPE has a high degree of short and long chain branching, which means that the chains do not pack into the crystal structure as well. It has, therefore, less strong intermolecular forces as the instantaneous-dipole induced-dipole attraction is less. This results in a lower tensile strength and increased ductility. LDPE is created by free radical polymerization. The high degree of branching with long chains gives molten LDPE unique and desirable flow properties. See www.wikipedia.org/wiki/LDPE

As discussed in the Appellants' brief, XLPE or "cross-linked" polyethylene is **not equivalent** to low density polyethylene (LDPE) because they have different properties. XLPE *is* **crosslinked or cured**. *See attached information on Cross-linked Polyethylene.*

The Examiner alleged that XLPE and LDPE have the same density. Appellants submit that although the XLPE and LDPE may have the same density, they have great differences in electrical and thermal properties. The crosslinked polyethylene (XLPE) as disclosed in the prior art **required a cured process in order to obtain its heat resistance** and thus, have **high dielectric constant**. It is well known in the art that the dielectric constant is an **essential** piece of information when designing capacitors and in other circumstances where a material might be expected to introduce capacitance into a circuit. *If a material with a* **high dielectric constant** *is placed in an electric field,* the magnitude of that field will be measurably **reduced** within the volume of the dielectric.

In contrast, the low density polyethylene (LDPE) employed in the present invention has **no** thermal extended properties because they are **not cross linked** and **has a low dielectric constant** which provides **low capacitance for transmission properties**. It is submitted that XLPE is not equivalent to LDPE in their properties. XLPE can not be employed as insulation in a cable of the present invention that requires low capacitance. It is submitted that low dielectric properties are important in a signal cable because of the high frequency. *It is well known in the art that in a signal cable, the energy is in the form* of electric and magnetic properties. For power cable, the dielectric characteristics are different from a communication cable as claimed in the present invention. The dielectric properties are less critical and can withstand DC voltage.

D. Chan's Water Swellable Yarns in combination with swelling agents, e.g., polyacrylamide, starch graft coplolymer of polyacrylic acid, and carboxy methylcellulose

Chan required the use of water swellable element WSE (5) such as yarn, filament, *strand or strip in combination with swelling agent such as polyacrylamide, starch graft* copolymer of polyacrylic acid, and carboxy methylcellulose. Chan required that WSE (5) is in *contact* with the "plurality of"CN wires in order to block the passage of water *within the cable in the longitudinal direction. The WSE employed are starch graft*

copolymer of polyacrylic acid or carboxymethylcellulose.[3] The functional group in polyacrylic is **acyl group** while in polyester, the functional group is an **ester group**. In addition, starch and carboxymethylcelluylose are classified as polysaccharides. Thus, besides being classified as polysaccharides, having different functional group and *different form, i.e., yarn, filament, strip or strand* from polyester tapes or fibers of the presently claimed invention. It is submitted that carboxymethyl cellulose (CMC) is a cellulose derivative with carboxymethyl groups bound to some of the hydroxyl groups of the glucopyranose monomers that make up the cellulose backbone. The polysaccharides or polyacrylic are **not functionally equivalent** to the polyester material of the presently claimed invention.

The Examiner proposes that Chan et al.'s polysaccharide copolymers in the form of yarn, filament, strip or strand and in contact with the "plurality of" CN wires can be employed and achieve the dry, water resistant cable of the presently claimed invention.

Appellants disagree. It is submitted that it is highly unlikely that one of ordinary skill in the art would substitute a polyester fiber or tape for the polysaccharide filament, strips or yarn of Chan et al.

Thus, Chan taught away from the present invention because the Appellants'cable required the use of polyester fibers or tapes for water protection element (16). Chan employs starch graft copolymer of polyacrylic acid, carboxymethylcellulose yarns, filament or strip in order to maintain contact with insulation shield. Note col. 3, lines 56-63. Moreover, the Appellants' cable employ

Moreover, Chan taught away from the presently claimed invention because it avoids the use of tapes for its water swellable elements. For example, Chan discloses at col. 2, lines 21-26 as follows:

> The use of a layer of water swellable tape over the length of the cable increases the overall diameter and weight of the cable which in many instances, is **undesirable.** Also the **cost associated with the application of water swellable tape and powder is significant and will translate into a higher cost of the cable.**

Furthyer, Chan discloses at col. 3, lines 55-64 as follows:

> "...The water swellable element, such as **yarn, filament strand or strip** may be non-conductive or semi-conductive. The reason for which it can be non-

[3] Starch and carboxymethylcellulose are classified as "polysachharide" and are linked through glycosidic linkages. *The functional group of polyacrylic acid is an acyl group while in* polyester, the functional group is an ester group. These functional groups and classification are not equivalent.

conductive is that CN wires will still maintain a substantial (over 90%) contact with semi-conductive insulation shield of the cable core on which the CN wires are applied. ***This is different from the use of tape*** covering entire cable core and which must be semi-conductive to maintain such electrical contact...."

In addition, Chan further discloses at col. 6, lines 14-17 as follows:

"...Moreover, the arrangement according to the invention **provides an improved construction in relation to the one that would use only tapes** over the entire length of the cable..."

From the above, Appellants submit that Chan teaches away from the **use of water swellable tapes** of the presently claimed invention, Chan uses water swellable **yarns** or **fibers**.

It is submitted that Chan et al. **teaches away** from the present invention. MPEP § 2145 section X.D. "References Teach Away from the Invention or Render Prior Art Unsatisfactory for Intended Purpose."

The issue is whether it would have been obvious to a person of ordinary skill in the art at the time Appellants made his invention to modify Chan et al. with either Belli et al or Goehlich in order to achieve a dry, water resistant coaxial cable of the present invention. In considering the question, it is to be noted that there must be some reason, *apparent* to one of ordinary skill in the art, for modifying the prior art to arrive at the claimed invention. See *In re Samour*, 571 F.2d 559, 563, 197 USPQ 1, 4 (Cust. & Pat.App.1978).

As discussed above, Chan et al. would not have provided the motivation or suggestion to modify the CNW of Chan with Belli et al. or of Goehlich to arrive at the claimed invention. First, Chan et al. provides not the faintest suggestion or motivation why it would be desirable to use the CNW in Belli et al.or vice versa. The external conductor of Belli is continuous whereas Chan's plurality of stranded CNW is non-continuous. Second, even if a cable of the type taught in Belli et al. were supplied with stranded CNW, **the resulting cable would not meet the limitations of the claims of the present invention.**

Even disregarding the fact that the CNW may be used, another component which is used by Chan is XLPE. It would not be obvious to use XLPE for LDPE or medium density polyethylene (MDPE) or heavy density polyethylene (HDPE) because the

properties of the resulting cable would be different from the coaxial cable of the present invention as discussed above.

Moreover, in determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); *Schenck v. Nortron Corp.*, 713 F.2d 782, 218 USPQ 698 (Fed. Cir. 1983). "Because that insight was contrary to the understandings and expectations of the art, the structure effectuating it would not have been obvious to those skilled in the art." 713 F.2d at 785, 218 USPQ at 700 (citations omitted).).see MPEP 2141.02 Differences Between Prior Art and Claimed Invention.

It is submitted that in the present case, Appellant's own disclosure provides the **only** suggestion of record that a) a first layer of LDPE mixed with vinyl or acrylic adhesive; b) a second layer of polyethylene mix consisting of LDPE or LDPE, MDPE or HDPE with a swelling agent; c) a reinforcement layer similar to first layer; d) external conductor made of aluminum or copper alloy tape; e) water protective element made of swellable fibers or tapes of polyester and f) protective cover made of LDPE, MDPE or HDPE are desirable components for a coaxial cable for use in cable TV. It is submitted that an Appellants' disclosure **cannot** be used against him. *In re Wertheim,* 541 F.2d 257, 269, 191 USPQ 90, 102 (Cust. & Pat.App.1976); see In re Leslie, 547 F.2d 116, 120, 192 USPQ 427, 430 (Cust. & Pat.App.1977).

E.Examiner's Answer

It is submitted that there is **no disclosure or suggestion regarding dry, water resistant** coaxial cable in Chan et al. The Examiner alleged on page 4 of Examiner's Answer, item C as follows:

> …"Chan discloses a **dry, water resistant coaxial cable** (Figs 1-8) which provides improved protection against migration of water….
> **Chan discloses** a cable (Fig.3) comprising a metal conductor

> element (11), a dielectric element (2-4) around core conductor (11) which is based on three layers: comprising a **polymer mixed with an adhesive component...**

The Examiner alleged on page 6, first full paragraph of Examiner's Answer as follows:

> "...However, Chan **doesn't necessarily disclose the first layer comprising an adhesive** (claim 11) nor the adhesive being selected from the group of vinyl adhesive, acrylic adhesive and combination thereof (claim 23), nor the adhesive being selected from the group consisting of ethylene acrylate acid, ethylene vinyl acid, and combinations thereof (claim 20) nor the absorption speed being 15 mg/g/min nor the absorption capacity of more than 30 ml/g (Claim 24)...."

The Examiner Answer was **inconsistent** with respect to the disclosure of Chan. First, Chan discloses a polymer with an adhesive component and second, Chan does **not** disclose a polymer with an adhesive. The Examiner Answer was replete with inconsistencies.

It is submitted that there is **no** disclosure or suggestion in Chan regarding a polymer with an adhesive component.

Moreover, there is no disclosure or suggestion regarding the absorption capacity of more than 30 ml/g nor the absorption speed of 15 mg/g/min.

In *In re Aller*, 105 USPQ 233 (CCPA 1955), the Court set out the rule that the discovery of an optimum value of a variable in a known process is normally obvious. However, Courts held that there are **<u>exceptions</u> to this rule in cases where the results of optimizing a variable which was known to be result effective, were unexpectedly good**. See *In re Waymouth*, 182 USPQ 290 (CCPA 1974); *In re Saether*, 181 USPQ 36 (CCPA 1974). Further, the court in *In re Antoine*, 195 USPQ 6 (CCPA 1977) pointed out that another exception is one in which the parameter optimized was ***not* recognized** to be a result effective variable. It further stated that §103 directs attention to the invention "as a whole" which includes not only to the subject matter which is literally recited in the claim in question but also those properties of the subject matter *and* are disclosed in the specification.

In this case, the question "as a whole" are the absorption speed and absorption

capacity, diameter/thickness of protective cover, external conductor thickness and diameter on the pipe, core conductor cross section diameter, diameter of reinforcement layer and *their inherent properties. These properties are configured/designed with the* structure of the dry, water resistant coaxial cable which does not use a filler but incorporated a water protection penetration element. This property permits Appellants to prepare and connect the coaxial cable *without using solvents and other cleaning agents.* Thus, it is submitted that it is the invention "as a whole" and not some part of it must be obvious under 35 USC 103.

The issue is whether the differences between the parameters of the prior art and the parameters of the Appellants' invention "as a whole" are such that the Appellants' *invention "as a whole" would have been obvious. It is submitted that it would* <u>not</u> have been obvious. There is no disclosure or suggestion in Chan et al, Goehlich et al. or Belli et al. to recognize the absorption speed or absorption capacity, diameter/thickness of protective cover, external conductor thickness and diameter on the pipe, diameter of reinforcement layer of the Appellants' invention when a) Chan et al. <u>avoids</u> the use of adhesive. Rather, Chan et al. use a "plurality" of stranded concentric neutral wires (CNW) <u>distributed</u> around the water swellable polymer; b) Belli et al. use *fillers* which is the opposite objective of present invention, i.e., <u>avoids the use of fillers</u>; c) Goehlich et al. *is directed to detecting water intrusion in a simple cable comprising an inner sheath*, an outer sheath and a sensor. It is submitted that recognizing the different cable configuration/design is essential to the unobviousness of the presently claimed invention.

A "structured material" is incorporated between the inner cable sheath and outer cable sheath. The definition of "structured material" is **broadly disclosed** in col. 4, lines 25-35. It can be a "swellable material" or adhesive layer or sealing material. The Examiner alleged that one of ordinary skill in the art can "pick and choose" a specific adhesive from a plethora of various "**structured material**" disclosed in Goehlich. The <u>Examples and claims of *Goehlich et al.* employ the use of **sputtered adhesive and sealing material**</u>. The primary object of Goehlich et al. is to provide a cable for detecting water in interstices between outer sheath and inner sheath. Note col. 3, lines 8-11. It is a monitoring system for measurement accuracy and lifetime of the cable.

The Examiner alleged that an adhesive component may be selected from a

plethora of various polymers listed in Goehlich. From the broad disclosure of polymers which can be used as "structured material," it is submitted that one of ordinary skill in the art does not have any *guidance or direction* on which polymer from Goehlich et al. may be incorporated in Chan et al. to obtain a modified cable which will provide the properties similar to the Appellants' presently claimed dry, water resistant coaxial cable.

The mere fact that references can be combined or modified does not render the resultant combination obvious *unless the prior art also suggests the desirability of the* combination. *In re Mills*, 16 USPQ 2d (Fed. Cir. 1990).

There is no disclosure or suggestion in Goehlich et al. regarding **"picking and choosing"**,e.g., pick a specific adhesive, as employed in the presently claimed invention and choose the specific adhesive from a plethora of various polymers in Goehlich et al. and incorporate the chosen specific adhesive in Chan et al. Rather, Chan et al. employ a plurality of stranded concentric neutral wires (CNW) distributed around the water swellable yarn to provide the necessary shield.

The Examiner used Belli et al. to show that a swelling agent can be employed to modify the cable of Chan et al. However, Appellants question how one of ordinary skill in the art would modify the cable of Chan upon reading the disclosure of Belli et al. Belli et al. disclose an expanded layer (5) which is **semi-conductive**. Belli et al. adds carbon black to the expanded layer. **Example 3** of Belli et al. provides as follows:

a) inner semiconductive layer EPR (ethylene/propylene copolymer) with carbon black;
b) insulating layer EPR filled with kaolin;
c) outer semi-conductive layer EVA (ethylene vinyl acetate) with carbon black;
d) a deposit of the expanded layer on the cable core.

In contrast, Chan et al.'s water swellable yarn is **non-conductive.** Moreover, Chan et al. provide the use of plurality of stranded concentric neutral wires (CNW) which are distributed around the water swellable yarn. There is no disclosure or suggestion to one of ordinary skill in the art to combine the swelling agent of Belli et al. with the swellable yarn of Chan et al. because CNW are distributed around the water swellable yarn. Moreover, the swellable yarn is **non-conductive** while Belli et al's expanded layer is **semi-conductive**. In addition, the conductor of Belli is **continuous** while Chan et al's

plurality of stranded CNW is **non-continuous**. There is no motivation or suggestion to combine Belli with Chan and arrive at the presently claimed invention.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are <u>not sufficient</u> to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

If the "suggested combination of references would require a substantial reconstruction and redesign of the elements shown in [the primary reference] as well as a change in the basic principle under which the [primary reference] construction was designed to operate." 270 F.2d at 813, 123 USPQ at 352.).

Similarly, in the present case, the expanded layer of Bell et al. is **semiconductive** while the water swellable yarn of Chan et al. is **non-conductive**. Chan et al. employ "plurality" of stranded concentric neutral wires (non-continuous) distributed around the water swellable yarn while Belli et al. employ carbon black and swelling agent on the expanded layer which is continuous. One of ordinary skill in the art confronted with the problem will not incorporate the swelling agent in the water swellable yarn which contain concentric neutral wires distributed around it because this combination would require a substantial reconstruction and design of the elements.

Even assuming *arguendo* that Chan et al is properly combinable with Belli et al., it is submitted that Belli et al. provide a <u>broad</u> <u>disclosure</u> of expanded layers at cols.5-6 as follow:

Upon reading Belli et al., one of ordinary skill in the art is confronted with various polymers, polymer components, or any type of polymers in the preparation of expanded polymers. Similarly, Belli et al. disclose a BROAD range of polymers for use as expandable polymer.

Appellants submit that of the above list of polymers, the Examiner's assertion that it would be obvious to one of ordinary skill in the art to "**pick and choose**" a specific polymer from a long list of disclosed polymer is erroneous.

Moreover, the Examiner's assertion that it would be obvious to "pick and choose" an adhesive, more particularly ethylene acrylate from the plethora od various polymers disclosed in Goehlich et al. is without support.

This would have required one of ordinary skill in the art to randomly or arbitrarily "pick and choose" among a number of different polymers, a plurality of ingredients such as blowing agents, fillers, photoinitiators, surfactants, a range of radiation polymerization conditions and characteristics. *In re Arkley*, 172 USPQ 524 (CCPA 1972).

The Examples did not provide any information or guidance which polymer or group of polymer components, one of ordinary skill in the art would "pick and choose" from a list of polymers. None of the polymers listed above provides the use of ethylene acrylate as an adhesive in Belli et al.

It is submitted that the Examiner's rejection falls short of what is necessary for an obviousness rejection. It has been found that a broad disclosure failed to constitute a description of a specific claimed compound. It has been subsequently stated that without specific direction, a general disclosure will not be sufficient to support an obviousness rejection. *In re Ahlbrecht*, 168 USPQ 293 (CCPA 1971)

One of ordinary skill in the art, wouldn't randomly or arbitrarily pick a specific swelling layer employed by the present invention and accomplish the necessary results achieved by the Appellants.

Thus, the Examiner used Goehlich et al. or Belli et al. "as a template to **pick** and **choose"** among several infinite variety of polymers to demonstrate obviousness of the claims. By "picking and choosing", one can thus find all the limitations, but the specification provides no direction, let alone "full, clear, concise and exact" direction required to the claimed combination. The same "picking and choosing" is required in order to arrive at all the claimed combinations. When one has to "pick and choose" among a wide variety of polymers, structured materials, tapes, self adhesive, sealing agents, the subject matter of the claimed invention has not been described as required by the statute. Possession of the subject matter at the time of the invention has not been demonstrated. One of ordinary skill in the art would have to "pick and choose" through Goehlich et al. or Belli et al.'s specification in order to find the "claimed limitation."

It is impermissible to **"pick and choose"** from any one of the reference only so much of it as will support a given position to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art. *In re Wesslau*, 147 USPQ 391 (CCPA 1965).

The Examiner alleged in his Examiner Answer dated February 18, 2010 on page 5, as follows:

> "…Chan discloses a cable (Fig.3) **consisting** of a metal conductor element (1), a dielectric element (2-4) around the core conductor (1) as an uniform layer (col. 5, lines 17-26) and being a material such as XLPE (i.e., low density polyethylene, col. 4, lines 19-25, a second layer (3) **comprising a cellular expansion polymer (i.e. XLPE) on first layer** (2) being applied to the conductor (1) as a uniform layer (2, [sic] col. 5, lines 15-25), wherein cellular expansion polymer is low dielectric coefficient polymer (i.e. XLPE, col. 5, lines 15-25)and a third layer (4) **comprising a reinforcement layer on the second layer** (3, col. 5, lines 15-25), wherein the first layer and the third layer (2 & 4) **may comprise a material such as (i.e. XLPE, low density polyethylene,** col. 4, lines 19-25), which have same characteristics (i.e., the first and third layer may be the same material XLPE), a second external conductor (6) surrounding the dielectric element (4) **consisting** of water penetration protective element (i.e. swellable tape, col.6, lines 1-7) capable of keeping the cable dry (col. 1, lines 5-16) wherein water penetration protective element (5d) **may comprise** plurality of swellable fibers (5 & 5d) as shown in Fig. 8) made of polyester fibers (col. 3, lines 64-67) and a protective cover (7) that may be made of low, medium or high density polyethylene (col. 5, lines 37-40. .."

Upon review of Chan at Col. 5, lines 17-26, it does not disclose the above statements. Appellants' claim imitation using "consisting of". The Examiner uses Appellants' own invention as the template for his rejection.

Measuring a claimed invention against the standard established by §103 requires the oft-difficult but critical step of casting the mind back to the time of the invention to consider the thinking of one of ordinary skill in the art guided only by prior art references and then accepted wisdom in the field. We <u>can not use hindsight</u> reconstruction to "**pick** and **choose"** among isolated disclosures in the prior art to deprecate the claimed invention. *In re Fine*, 5 USPQ 2d 1780 (Fed. Cir. 1988).

Design is a critical element of the present invention. The Appellants have developed a dry, water resistant coaxial cable which does not use fillers.

From the above, the Examiner has <u>not</u> shown the motivation to "choose/select" a) ethylene acrylate as an adhesive; or b) swelling agent from a multitude of polymers, combination of multitude of polymers disclosed in Goehlich et al. or Belli et al.

Further, the ability of one of ordinary skill in the art to prepare a swellable polymer *does not* lead the artisan to achieve the presently claimed cable because there are several factors to be considered, e.g., manipulation of the layering/configuration, design

of different polymer layers; addition of adhesives to 1st and 3rd layers, addition of swelling agent on 2nd layer; the 2nd conductor element containing the water protection element, absorption capacity, absorption speed, diameter or thickness of different layers.

Moreover, the claims at issue recite specific combinations of characteristics/properties which were not addressed by the Examiner. Rather, the Examiner attempted a "broad conclusory statements " regarding the teaching of Belli et al. and Goehlich et al. **Broad conclusory statements, standing alone are not evidence,** *In re Dembiczek*, 50 USPQ 2d 1614 (Fed. Cir. 1999) at 1617.

F.Transitional phrase "consisting of"

It is submitted that the phrase "consisting of" narrows the scope of the presently claimed invention. See for example, Appellants' Claims 68-75. The claims directed to dry coaxial cable and manufacturing method thereof are substantially narrowed to the recited elements or embodiments (or steps) and **nothing more**. Appellants submit that the introduction of other components or additional steps would materially change the characteristics or properties of Appellants presently claimed invention. *In re De Lajarte*, 337 F.2d 870, 143 USPQ 256 (CCPA 1964). See also *Ex parte Hoffman,* 12 USPQ2d 1061,1063-64 (BPAI1989).

It is submitted that the Examiner *ignored* the transitional phrase "consisting of." The scope of the claims of the present invention is substantially *limited* to the designated elements, configuration or material of the presently claimed dry, water resistant coaxial cable, as well as the order of the position of each of the elements as recited and nothing more. The above discussion have been argued in the Appellants' brief.

G. Dependent Claims

Claim 69 The dry coaxial cable according to claim 68 wherein the core conductor is copper plated aluminum wire, with a uniform circular cross section of 3.15± 0.03 mm diameter.

Chan at Col. 5, lines 11-13 discloses the stranded conductor can be made of Cu or Al wires. There is ***NO DISCLOSURE OR SUGGESTION*** regarding "uniform circular cross section of **3.15± 0.03 mm** diameter" in the cited prior art. It is submitted that Claim 69 is unobvious over the cited prior art.

Claim 70 The dry coaxial cable according to claim 68 wherein the adhesive component is chosen between ethylene acrylate acid or ethylene vinyl acid permitting better adherence and water resistance between the core conductor and the dielectric element.

It is submitted that Claim 70 is unobvious over the cited prior art. There is no disclosure or suggestion to one of ordinary skill in the art to pick and choose a specific adhesive from a plethora of polymers in the secondary references and incorporate it in the primary references because they are not combinable.

Claim 71 The dry coaxial cable according to claim 68 wherein the second polyethylene film applied onto the core conductor shows better watertightness to the swellable dielectric improves its superficial appearance and offers a 13.0 ± 0.10 mm diameter.

Figure 8 of Chan **does not disclose or suggest** "second polyethylene film applied onto the core conductor. shows better watertightness to the swellable dielectric improves its superficial appearance and offers a **13.0 ± 0.10 mm diameter**." It is submitted that Claim 71 is unobvious over the cited prior art.

Claim 72 The dry coaxial cable according to claim 68 wherein the external conductor is formed by a tape made of aluminum or copper alloy or mixture thereof is formed in a cylindrical pipe and can be longitudinally welded, extruded or the edges can be overlapped and it has a thickness of 0.34 mm and the diameter on the pipe is 13.7 ± 0.10 mm diameter.

Chan at col. 5, lines 28-20 discloses that the water swellable yarn 5 is helically wound over the insulation shield 4 under **CN wires** 6 with a lay opposite to that of said CN wires 6 so that it criss-crosses the same as shown in FIG. 1. The CN wires 6 are generally copper or aluminum wires or straps wrapped helically around and in intimate contact with the insulation shield 4. When reference is made herein to the water swellable yarn 5, it should be understood that it may be replaced by any continuous, elongated water swellable element, such as a filament, a strand, a strip or the like, which is preferably applied with a number of turns ranging from 1 to 30 per meter of cable or of the cable core which consists of parts 1, 2, 3, and 4. On top of CN wires 6, there is extruded an encapsulating jacket 7 made of a polymeric material such as a linear low

density polyethylene, medium density polyethylene or semi-conductive polyethylene.

There is **no disclosure or suggestion** that the external conductor is formed by a **tape** made of aluminum or copper alloy or mixture thereof is formed in a cylindrical pipe and can be longitudinally welded, extruded or the edges can be overlapped and it has a thickness of 0.34 mm and the diameter on the pipe is **13.7 ± 0.10 mm diameter.** It is submitted that Claim 72 is unobvious over the cited prior art.

Claim 73 The dry coaxial cable according to claim 68 wherein the water penetration protective element **consists** of swellable tapes placed helically, annularly or longitudinally.

It is submitted that Claim 73 is unobvious over the cited prior art, as discussed above. There is no disclosure or suggestion in cited prior art regarding water penetration protective element.

Claim 74 The dry coaxial cable according to claim 73 wherein the moisture protection elements have an absorption speed of ≥ 15 ml/g per minute and their absorption capacity is over 30 ml/g.

Chan at Col. 4, lines 14-18 **does not disclose or suggest** moisture protection elements have the specific absorption speed of ≥ 15 ml/g per minute and their absorption capacity is over 30 ml/g. Rather, it discloses that the water swelling elements suitable for the purposes of the present invention should normally have at least 50% swelling capability. Also if semi-conductive materials are desired, the elements would normally be loaded with carbon black. It is submitted that Claim 74 is unobvious over the cited prior art, as discussed above.

Claim 75 The dry coaxial cable according to claim 68 wherein the external cover is made of medium density polyethylene and has a diameter on cover of 15.5 mm ± 0.10 mm with a 0.67 mm ± 0.02 mm thickness.

It is submitted that Chan at Col. 5, lines 37-40 **does not disclose or suggest** the external cover is made of medium density polyethylene and has a specific diameter on cover of 15.5 mm ± 0.10 mm with a 0.67 mm ± 0.02 mm thickness. Rather, Chan

discloses XLPE and crosslinked polyers. It is submitted that Claim 75 is unobvious over the cited prior art, as discussed above.

The Examiner alleged that the manipulation of these parameters are well within skill of a person skilled in the art. However, Appellants submitt that the water absorption capacity and speed are provided not for the different diameters of the cable. This is provided by the binder tape applied over the aluminum pipe and the polyethylene jacket. The water absorption speed and capacity are provided by the super-absorbent polymer dust that the binder has. It is submitted that it is the manipulation of the different components of the Appellants' coaxial cable that provided the specific parameters and are not well within the skill of an ordinary person skilled in the art. When the second polyethylene *film is applied onto the core conductor, it has 13.0 ± 0.10 mm diameter.* In order to show better watertightness to the swellable dielectric and improved superficial appearance, Appellants submit that the second layer and the foam dielectric are extruded at the same time. Both the polyethylene layers are melted and the second layer covers the foam when both are melted to provide the watertightness to the swellable dielectric and improve its superficial appearance.

A person of ordinary skill in the art (POSA) familiar with the problems of water penetration in coaxial cables understood that "plurality of" stranded CNW are <u>not equivalent</u> to or could not be incorporated or substituted for the external conductor (15) of the present invention because of the following reasons: a) the transitional phrase "consisting of" <u>did not allow</u> for the presence of "plurality of" stranded CNW. The "comprising" language in Chan <u>provided</u> "plurality of" stranded CNW and other elements in different variations and embodiments in combination with the water swellable elements, the combinations of which were **not allowed** in Appellants' cable, i.e., it would materially affect the properties of the presently claimed invention; b) as discussed above, the "plurality of" stranded CNW are not continuous as compared to the external conductor of the present invention. This concept would not be applicable to coaxial cable because a **non-continuous** path will **not** provide the magnetic and electric path. It has to be a continuous conductor. The current will not flow because conductors are separate or stranded. The CNW will not work in a signal application as claimed in the present application. Moreover, The external conductor of the present invention has different functions. First is to provide to the coaxial cable a second conductor; Second,

the second conductor is a shield against electromagnetic fields because it completely encloses the inner conductor; and Third, the second conductor is completely hermetical (airtight) and provides protection against humidity. It is submitted that the CNW of *Chan et al. does not provide any of these functions.*

From the above, Appellants submit that the Examiner has not presented sufficient argument or reasoning to establish a prima facie case of obviousness. Appellants request *the reversal of Examiner's action in rejection claims 68-75 and allowance thereof are* respectfully requested.

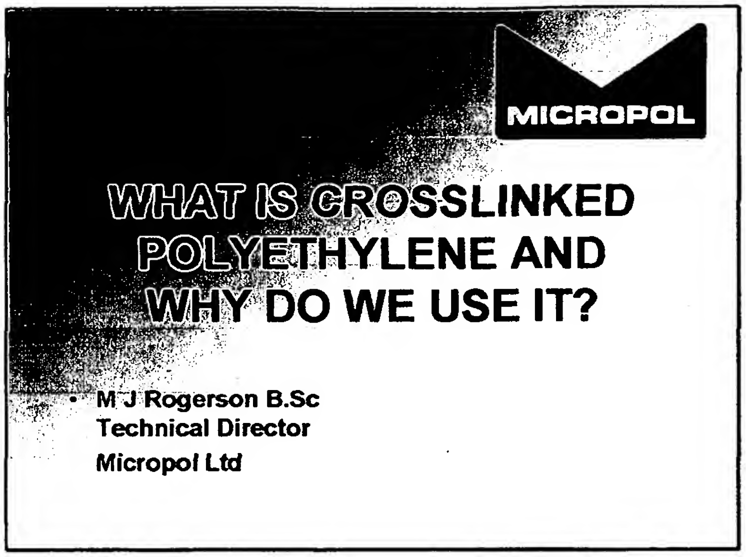
Respectfully submitted,

Carmen Pili Ekstrom
Reg. No. 34,981
Attorney for Appellants

LAW OFFICE OF CARMEN PILI EKSTROM
727 Sunshine Dr.
Los Altos, CA 94024
650 960-1936

Filed: May 18, 2010

Slide 1



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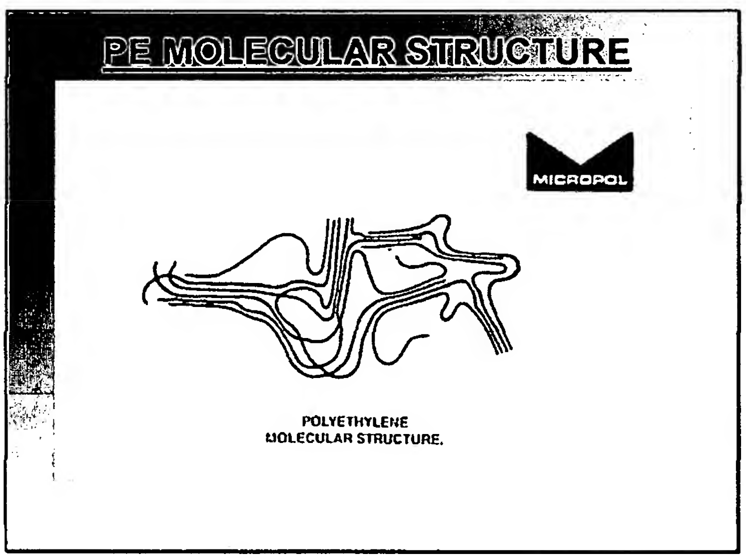

1.1 STRUCTURE *[Slide 2]*

To understand this topic we need to know a little about the basic structure of the polyethylene polymer. Polyethylene in its various forms is essentially a long chain carbon-based polymer. The chains are not linked directly to each other, but the basic structure is held together by entanglement of the long chains and, in the more crystalline areas, by weak intermolecular forces. Application of heat to this polymer allows the molecules to move relatively easily with respect to each other. The material is thus easily processed and its basic structure gives a tough, flexible material with excellent tensile and impact properties.

For example, high density grades of polyethylene having medium to high molecular weight and only short chain branches can be extruded into pipes which exhibit excellent pressure resistance and low creep characteristics at room temperatures.

However, at higher temperatures a major weakness of polyethylene is that the material starts to become softer and more elastic due to the polymer chains separating and moving and the material has less resistance to tensile and creep forces. Improvements in polyethylene's pressure performance can be made by adopting as near as possible a linear, i.e. an un-branched structure, and having as high a molecular weight as possible, but the basic property of lack of resistance to heat still applies.

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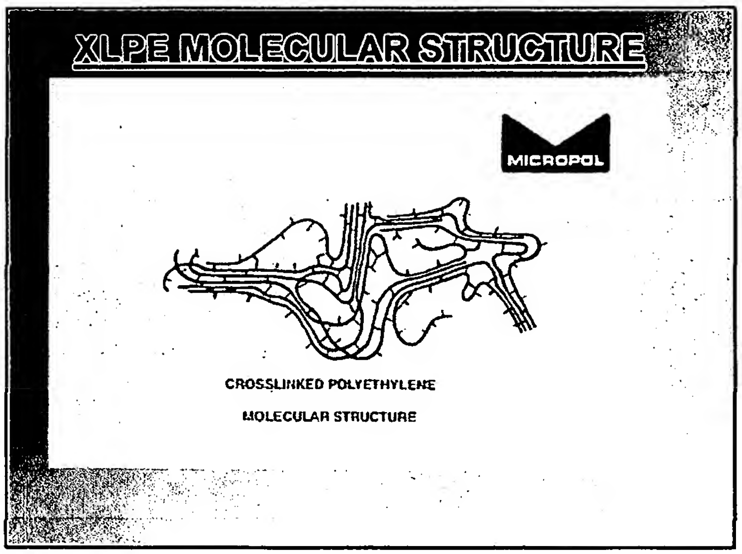
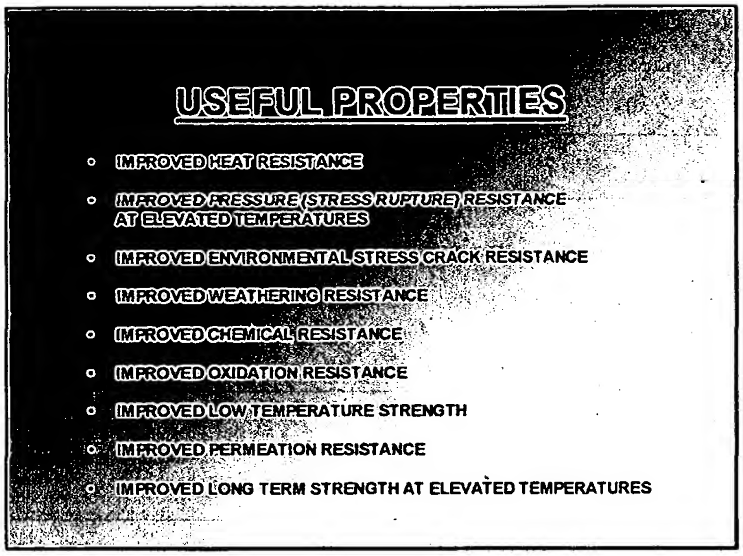


1.2 CROSSLINKED POLYETHYLENE *[Slide 3]*

The creation of direct links or bonds between the carbon backbones of individual polyethylene chains forms the crosslinked polyethylene structure. The result of this linkage is to restrict movement of the polyethylene chains relative to each other, so that when heat or other forms of energy are applied the basic network structure cannot deform and the excellent properties that polyethylene has at room temperature are retained at higher temperatures. The crosslinking of the molecules also has the effect of enhancing room temperature properties. Sioplas consists of chemically modified polyethylenes which are capable of being crosslinked.

Slide 4



WHAT USEFUL PROPERTIES DOES CROSSLINKING POLYETHYLENE GIVE? ***[Slide 4]***

2.1 TEMPERATURE RESISTANCE

Crosslinking polyethylene changes the polymer from a thermoplastic to a thermoelastic polymer. Once it is fully crosslinked, polyethylene tends not to melt but merely to become more flexible at higher temperatures.
Low density polyethylene film grades which have been designed for medical applications, for example, have been autoclaved at 130□C without losing their properties. Low density grades for cable, foam and foam tube applications have been thermally aged at 150□C, again without loss of properties. Medium and high density pipe samples have been thermally aged at 190□C without losing their shape and size.
The influence of crosslinking on polyethylene can be seen by the fact that non-crosslinked polyethylene grades melt at temperatures between 100 and 130°C.

2.2 PRESSURE RESISTANCE (STRESS RUPTURE RESISTANCE)

Crosslinking improves this property at room temperature, reducing tendency to creep. At high temperatures the improvement comes by reducing relative molecular movement. At elevated temperatures crosslinking allows the properties of the original base polyethylene to be preserved. Thus crosslinked high density polyethylene, which has closer packing of the chains and an intrinsically higher pressure resistance, is used for higher pressure applications than crosslinked low density polyethylene. So for flexible underfloor heating pipes a minimum density of 0.935 to 0.940 is necessary to meet relevant pressure regulations and for hot sanitary water pipes, which have to meet more stringent requirements, a minimum density of 0.945 to 0.950 is required. Crosslinkable polyethylene for hot sanitary applications will meet the standard DIN 16892 test, which has a pressure requirement of 8000 hours at 110°C at 2.8 mega pascals hoop stress.

2.3 ENVIRONMENTAL STRESS CRACK RESISTANCE (ESC)

Crosslinking polyethylene dramatically improves this property at room and elevated temperatures. High density homopolymers, grades of polyethylene which fail dramatically under the influence of applied stress and known cracking agents can, in their crosslinked form, outperform high molecular weight polyethylene copolymers.

2.4 RESISTANCE TO UV LIGHT

There is some evidence that crosslinking improves performance in UV light. The theory behind this is that there are more bonds to break before embrittlement occurs.

2.5 CHEMICAL RESISTANCE

The basic crosslinked structure physically inhibits the diffusion of aggressive chemicals. The material is thus rendered more resistant to permeation and softening by these chemicals.

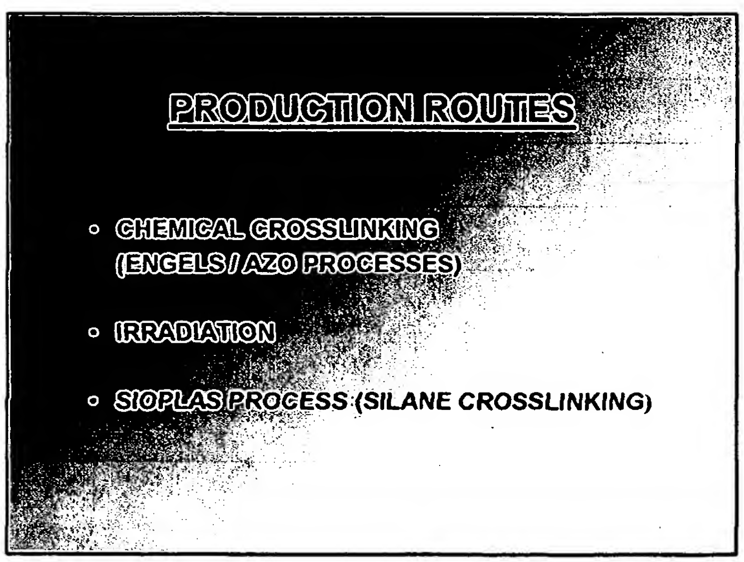
2.6 OXIDATION RESISTANCE

DSC and DTA measurements have shown that the oxidation resistance of crosslinked polyethylene is improved against the un-crosslinked version.

2.7 ROOM TEMPERATURE AND LOW TEMPERATURE PROPERTIES

Crosslinked polyethylenes historically have found their major applications in the cable and pipe industries at elevated temperatures. However, recent interest in the gas, oil and water distribution industries has led to a re-evaluation of XLPE's room and low temperature properties, particularly of impact and creep. Initial data suggests useful improvements over polyethylene in this area.

__Slide 5__



3 METHODS OF CROSSLINKING POLYETHYLENE *[Slide 5]*

These fall into three main types:

1. Chemical Crosslinking (Engels / Azo Process)
2. Irradiation
3. Silane Grafting and Hydrolysis (Sioplas Process)

3.1 CHEMICAL CROSSLINKING

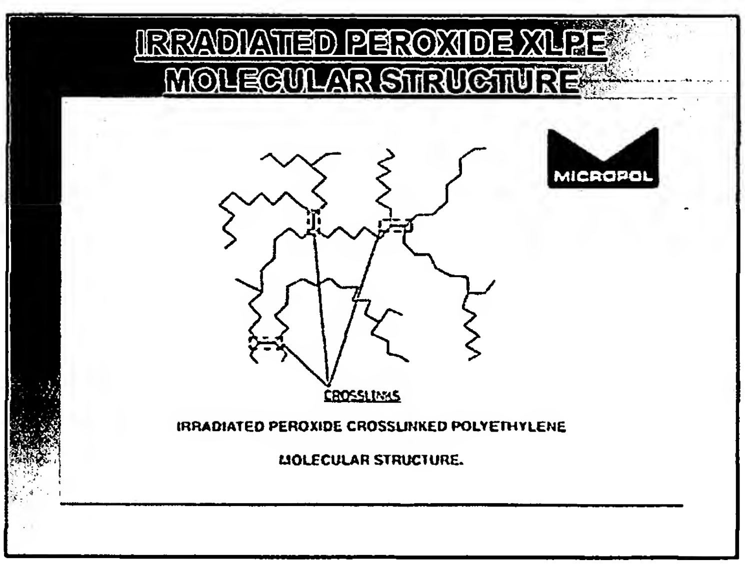
The Engels process uses polyethylene containing a high concentration of organic peroxide. The polyethylene is extruded and held at elevated temperatures for a period of time after extrusion inside long pressure tubes. During this time the peroxide decomposes to free radicals which react with the polymer to form carbon-carbon bonds between the polyethylene chains.

The high capital cost of the extrusion equipment necessary for this process has mitigated against its widespread introduction since the 1950's and 60's when it was the first crosslinked polyethylene to be commercially exploited.

The crosslinked structure created (direct carbon to carbon crosslinks between PE. chains) is two-dimensional / planar in character and not as ultimately effective as the Silane grafted structure. It is also restricted to extrusion processes. ***[Slide 6]***

The Azo process is similar in nature to the Engels process, using an Azo compound rather than a peroxide. The Azo compound decomposes at very high temperatures, normally in downstream catenary tubes, once again to form free radicals to crosslink the polyethylene chains together.

<u>Slide 6</u>

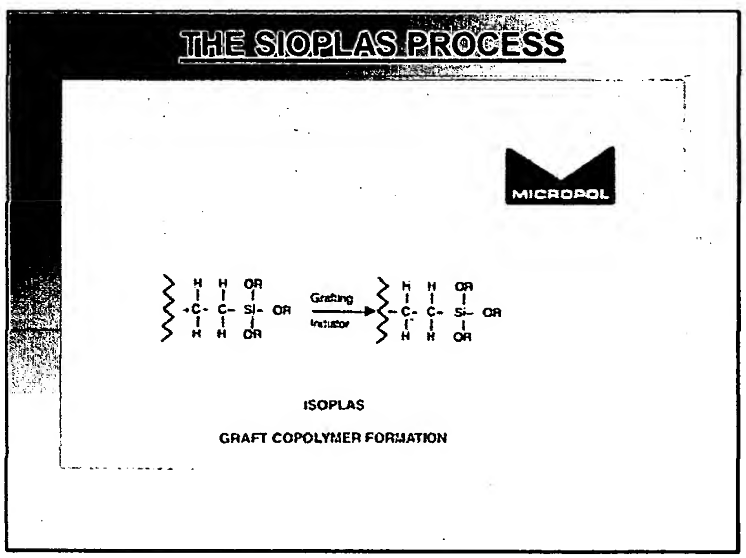


3.2 IRRADIATION

Moulded polyethylene articles or extrusions are passed through an accelerated electron beam (Beta or Gamma radiation) which forms free radicals in the polymer and links directly polyethylene chain to chain. The structure created is planar as in the peroxide (chemical) crosslinking system. The polyethylene used should ideally contain "co-agents", which adds to the raw material costs.

For pipe production, higher energy beams of up to 10 MeV have to be used to crosslink thicker walled tubes and large coils (several kilometres long) have to be produced, passed through the irradiation chamber, then rewound into smaller coils for sale. The purchase of an irradiation chamber deters all except the largest pipe extrusion companies. Time rental is the usual route for this process.

<u>Slide 7</u>



3.3 THE SIOPLAS PROCESS *[Slide 7]*

In this process crosslinkable graft copolymer is formed by grafting short side chains of organosilanes on to the main polyethylene structure. The resulting polymer is still thermoplastic. The grafting process is normally carried out in a high shear extruder. This is normally carried out on a Ko Kneader or twin co-rotating screw extruder, using the extruder as a chemical reactor. The moulder or extruder then blends this graft copolymer with a catalyst masterbatch and extrudes the still thermoplastic material to form the finished product. ***[Slide 8, 9]***

At this stage, e.g. pipe extrusion, injection moulding, only a very low level of crosslinking occurs. The bulk of the crosslinking is achieved later by reacting the pipes with moisture, either from hot water baths or a steam chamber. ***[Slide 10]***
The water molecules diffuse into the polyethylene and a chemical reaction takes place between water and the end groups of the organosilane side chains. This reaction forms siloxane crosslinks which directly join the polyethylene chains. ***[Slide 11].*** The catalyst present merely accelerates the rate of crosslinking and enables economically viable crosslinking times to be achieved. Importantly, the end of any silane side chain is capable of forming crosslinks with three different adjacent silane side chains. This gives a bunch-like crosslink structure having a three dimensional trellis type form. This final crosslink network can be shown to be more resistant to heat and pressure changes than the planar type structures given by the peroxide of irradiation routes. ***[Slide 12]***

Silane grafted polyethylenes are increasingly being exploited for a range of reasons.

a) They can be processed on any equipment capable of handling polyethylene.

b) The process separates the fabrication and the crosslinking steps. Each can be achieved at optimum conditions.

c) The capital cost is low. No process equipment modifications are required, merely the addition of a hot water tank or steam chamber for the actual crosslinking process.

d) The large range of polyethylenes available to be grafted and the nature of the grafting process allow Sioplas graft copolymers to be "engineered" or tailor-made to suit particular processing or product applications. Specific gravity, molecular weight distribution, viscosity, melt stability, crosslinking rate of finished product, can all be adjusted by choice of base polymer and formulation

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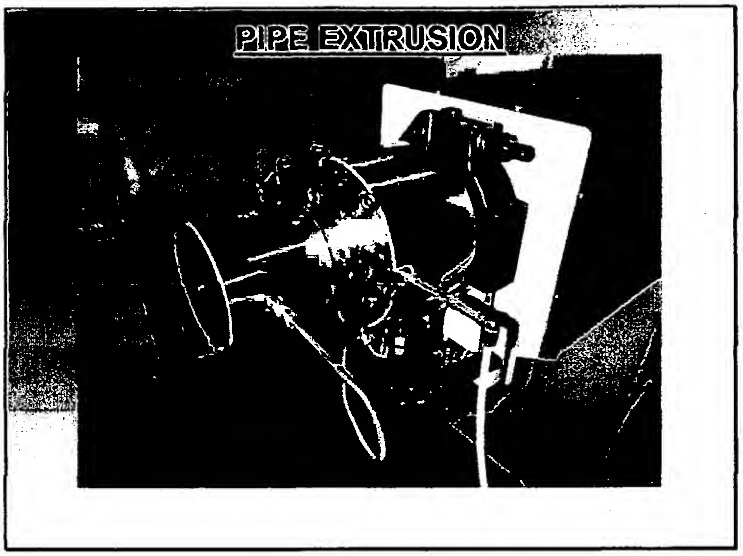

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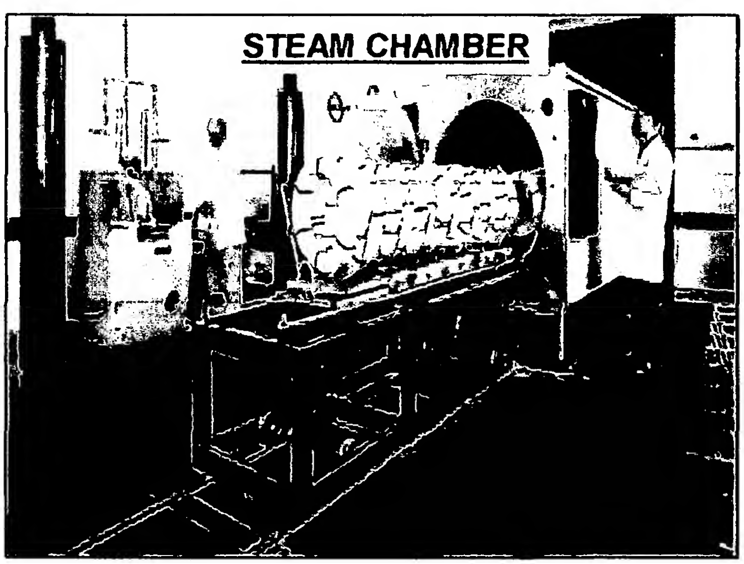

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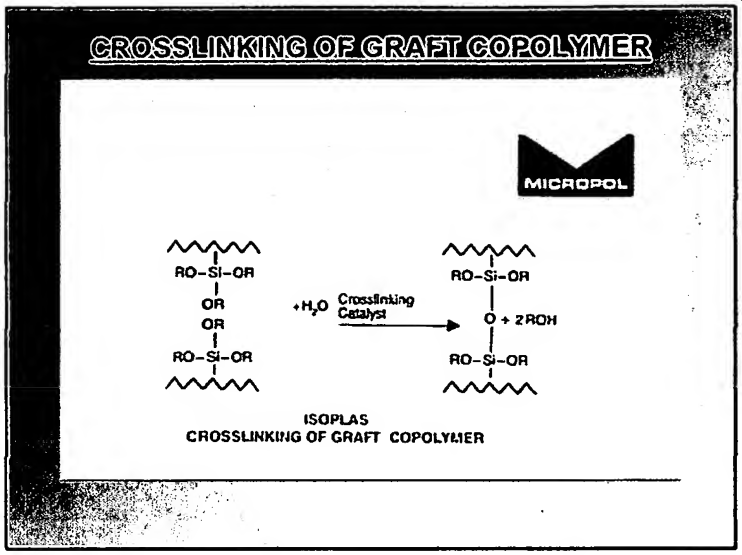

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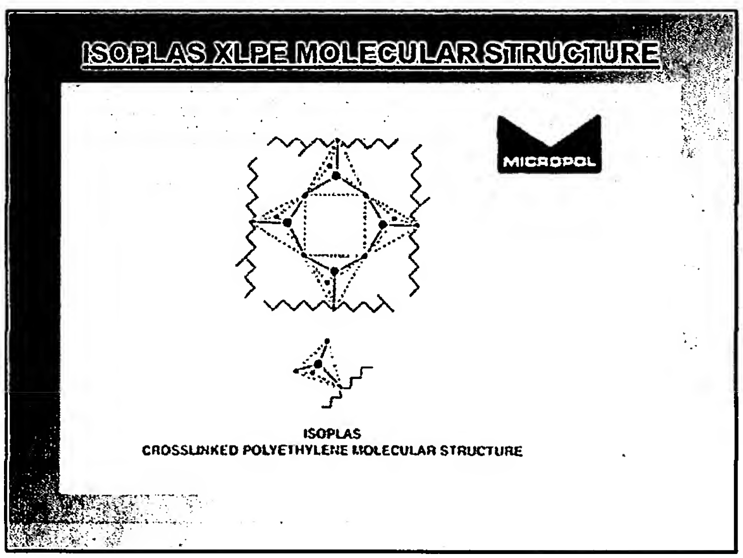

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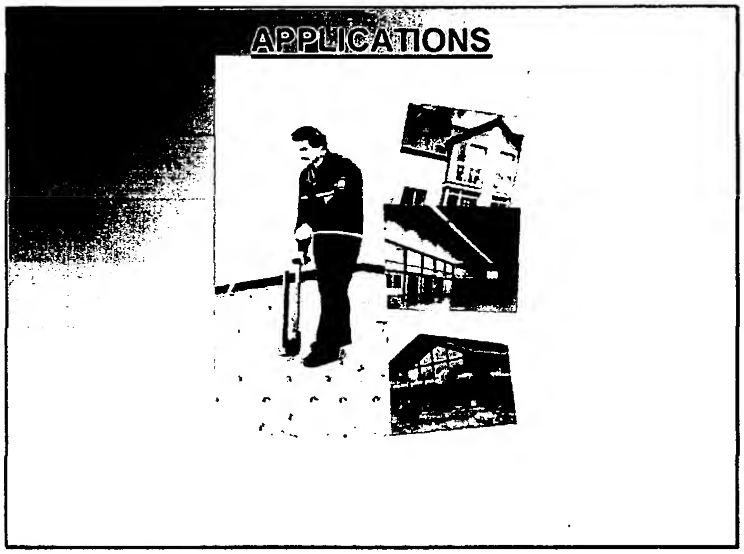

4. APPLICATIONS

4.1 ***[Slides 13-19]*** Since their introduction in the late sixties, silane grafted polyethylenes have largely been used in the production of power cables, where their use has enabled larger currents to be used without thermal breakdown or softening of the insulation. Together with the other forms of crosslinked polyethylenes, Silane grafted HDPE has achieved big penetration into the market for copper and mild steel replacement in domestic hot water systems. Traditionally the main markets have been in Scandinavia and Continental Europe, but now in the USA, Australasia and Japan XLPE is becoming the material of choice in new buildings and replacement systems. The main advantage over copper and steel is in the speed of installation with push fittings replacing brazed or mechanical joints. The material's insulation properties as well as its resistance to freeze bursts are also important.

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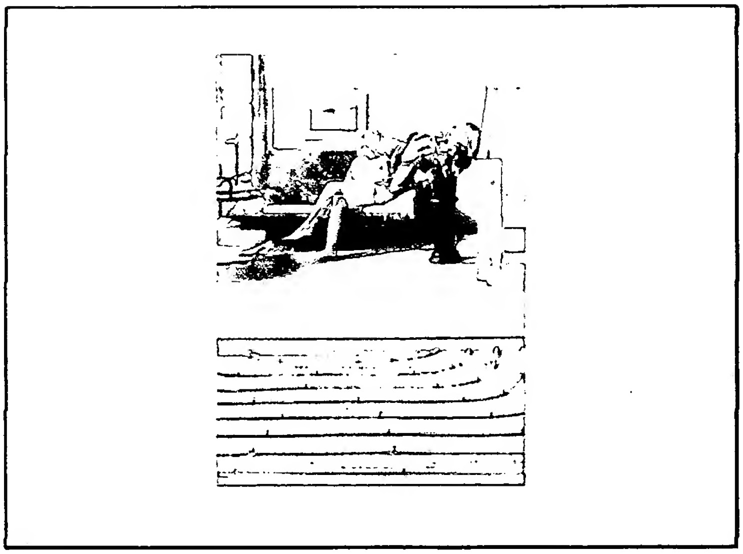

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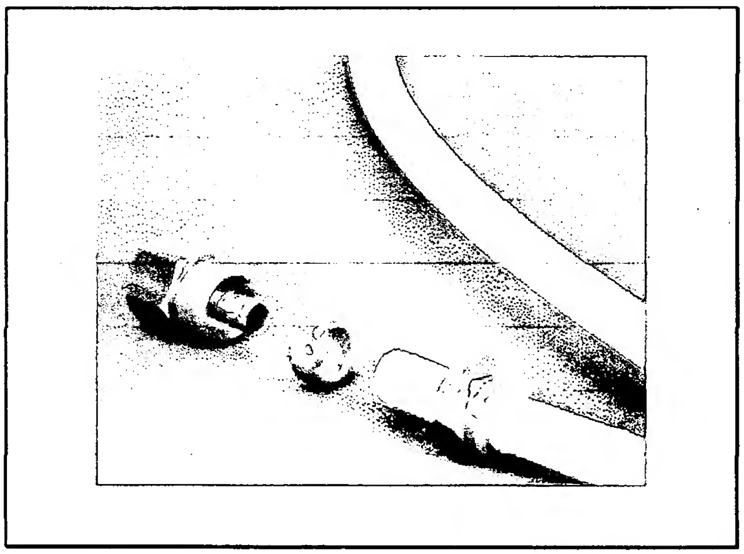

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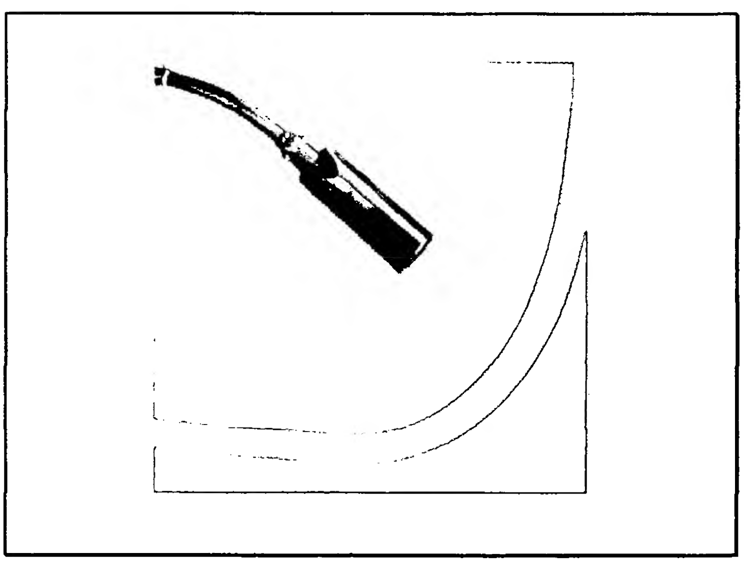

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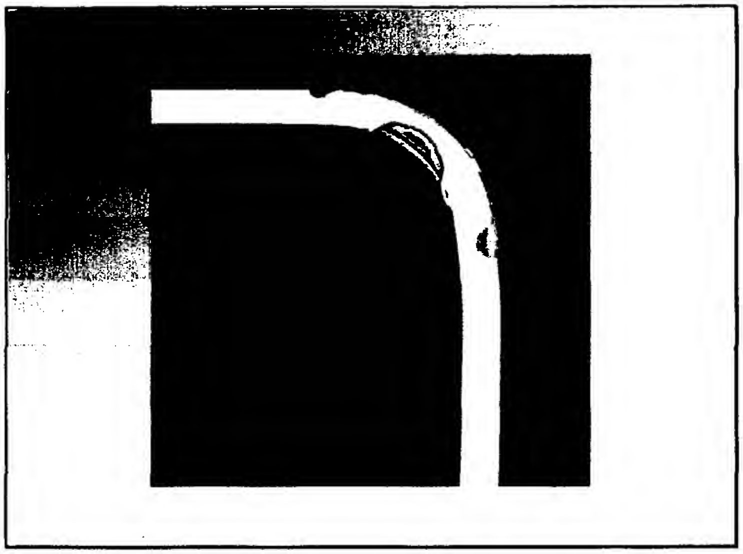

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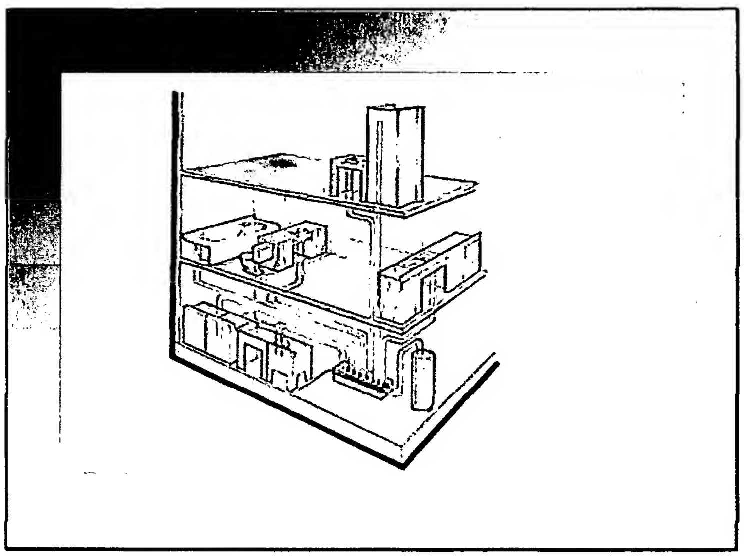

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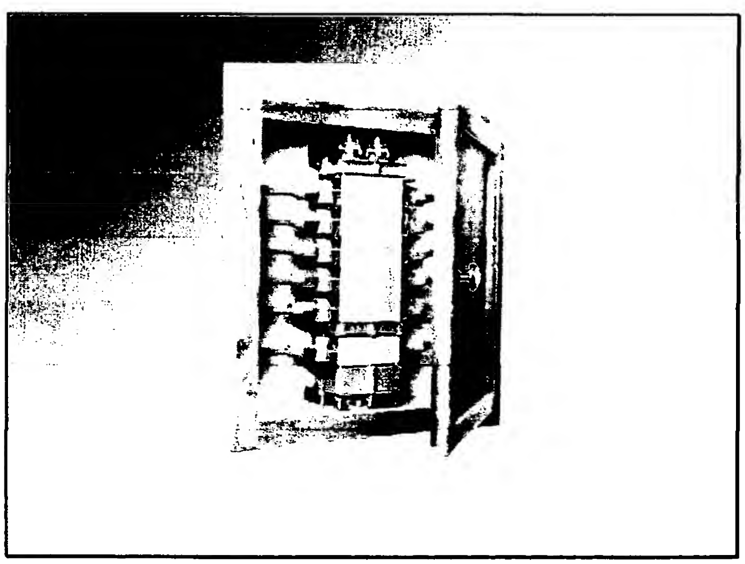

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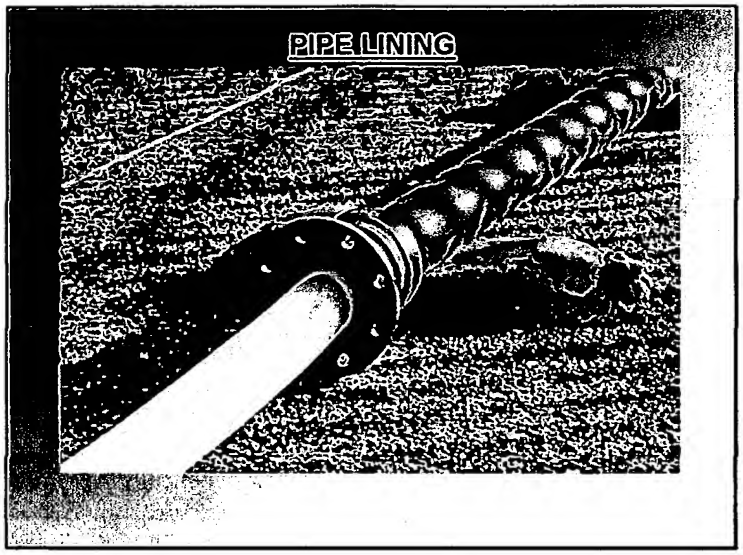


4.2 In the late nineties newer applications have begun to appear. ***[Slide 20, 21]*** The SPEX system first presented at the Plastic Pipes X conference in Gothenburg exploits the fact that, uniquely, uncrosslinked Silane grafted HDPE pipes can be produced at diameters of up to 1000mm. These can be welded together and then inserted into existing larger diameter metal pipe systems which have been corroded, damaged, etc., and are no longer serviceable. Once in place the Silane grafted pipe can then be expanded with hot or cold water under pressure to line and repair the pipeline. The crosslink network structure is formed during the expansion process and prevents the necking that would occur in expanding conventional HDPE liners. This system will be applied to the rehabilitation market for gas, oil and water pipes and also to produce new mild steel, XLPE-lined pipes to replace duplex stainless steel pipes in the offshore market. Once in place the XLPE liner will give temperature, chemical and environmental stress crack resistance.

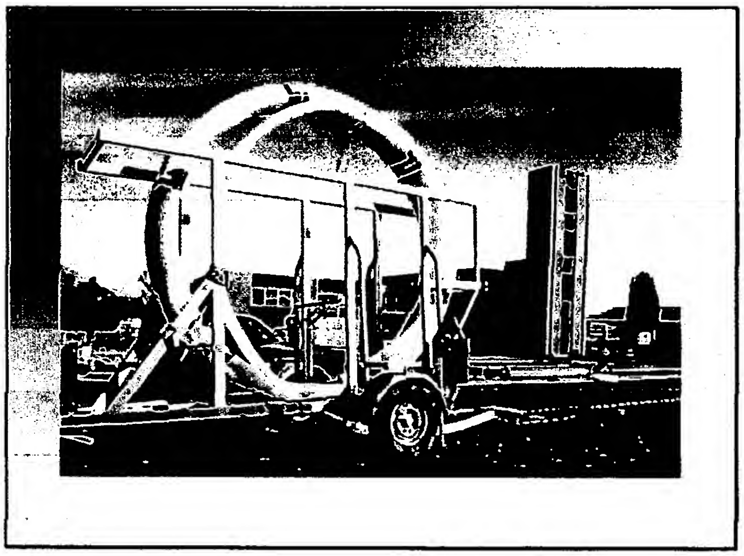
4.3 Silane crosslinked liners are now being used to protect nylon tubes from ESC attack by hot water / ethylene glycol mixtures in underbonnet applications.

4.4 Silane crosslinked injection moulding grades are now being used in pipe fittings. Here they are replacing acetal, polysulphone and polybutylene. Once again any component welding is carried out on the uncrosslinked moulding and the full assembly is then crosslinked.

4.5 The room temperature creep properties of XLPE can be exploited in PE gas pipes, which will withstand a higher pressure than conventional HDPE pipes and thus enable greater volume gas transmission rates to be achieved.

4.6 Coloured, fully crosslinked powders have been used as non-melting decorative particles in EVA and Surlyn Ionomer floor coverings.

__Slide 21__



5 SIOPLAS - FUTURE DEVELOPMENTS

The Silane grafting technique has allowed polyethylene to be "engineered" into a copolymer with a much wider envelope of useful properties and applications. Technically the same process could be used to broaden the scope of other commodity polymers. These engineered grafts would bridge the gap in properties and price between conventional thermoplastics and ultra-expensive high performance "engineering" resins. Already EVA, EBA and EPDM have shown promise. A patent exists for crosslinking polypropylene. Other polyolefin structures could well be worth looking at. The reactive nature of the Silane side chains may also be of use in bonding Silane graft copolymers to other polymers in composite structures or in the melt phase of alloys and blends.

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(54) Dry water-resistant coaxial cable and manufacturing method of the same

Trockenes wasserfestes Koaxialkabel und Verfahren zur Herstellung desselben

Cable coaxiale sec résistant à l'eau et son procédé de fabrication

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(73) Proprietor: **Servicios Condumex S.A. De C.V.**
C.P. 76120 Queretaro, QRO (MX)

(72) Inventors:
- **Yanez Martinez, Leonel**
  C.P 76120 Queretaro, Qro (MX)
- **Osornio Osornio, Victor**
  C.P 76120 Queretaro, Qro (MX)
- **Rodriguez Camacho, Raul**
  C.P 76120 Queretaro, Qro (MX)

(74) Representative: **Parnham, Kevin et al**
Swindell & Pearson
48 Friar Gate
Derby DE1 1GY (GB)

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] Currently, cable TV networks are designed taking into account the use of coaxial cables for signal transmission from the generation building to the subscribers. Said coaxial cables are classified in trunk, distribution and drop cables, and are usually made up of a core conductor, a dielectric insulation, and external conductor and a protective cover.

PREVIOUS ART

[0002] In order to connect coaxial cables to the transmission or reception equipment, it is necessary to prepare the cable to place and then seal the connectors to prevent water penetration. However, water penetration problems are common due to poor seal together with an inadequate cable installation. For example, when the cable is placed in ducts exposed to prolonged humidity such as flooding, if water penetration occurs, the cable is affected in its electrical and mechanical properties.

[0003] The current methods to prevent water penetration in this type of cables focus on the use of fillers such as oil dispersed water insoluble materials, and stabilizers based on glycol, ester acetate, ethylene glycol ester or ethylene glycol ester acetate. All these materials show an adequate protection against water penetration in coaxial cables, however all of them use materials with oily adhesive and/or characteristic properties. This complicates the use of solvents to clean the cable before connecting it.

[0004] For example, in U.S. Patent 5,949,018, a coaxial cable having water blocking cover is described, which includes, besides the conductor and the dielectric material around it, a first metal cover around the dielectric material and the conductor; a first metallic tape cover around and a second metallic cover around the tape; a water swellable material placed between the two covers and a second metallic tape, and a final jacket.

[0005] In patent application PCT/US01/11879, a coaxial cable is described. Said coaxial cable is protected against corrosion through the use of a composition applied on the cable, said composition being based on an oil dispersed anti-corrosion compound and a glycolic ethers stabilizer, propylenglycol based on glycolic ester acetate or ethylene. Said composition is applied preferably on the external conductor of said cable.

[0006] The applicant had developed a technique through the design of a dry cable, i.e. without filler, but incorporating within its design a water penetration prevention element, which would permit to prepare and connect the coaxial cable without using solvents and other cleaning elements.

DESCRIPTION OF THE INVENTION

[0007] Hereinafter, the invention is described according to figures 1, 2, 3 and 4 wherein:

Figure 1 is a perspective view with cross section of the dry coaxial cable.
Figure 2 is a side view with cross section of the cable of Figure 1.
Figure 3 is a block diagram of the manufacturing process of the dry coaxial cable in its first phase.
Figure 4 is a block diagram of the manufacturing process of the dry coaxial cable in its second phase.

[0008] The coaxial cable 10 of Figures 1 and 2 is characterized because it includes a protection to prevent water penetration, specifically between the external conductor 15 and the cover 17. Said cable also includes enough elements to ensure protection against water penetration and the method through which said protective element against water penetration is placed between the external conductor and the cover is presented.

[0009] The coaxial cable 10 is normally formed by a metal core conductive element 11 which can be manufactured from different materials such as: copper alloys, aluminum alloys, or combinations of said metals with others. Said core conductor can be protected by a surrounding layer 12 of a polymer mix with an adhesive component of ethylene acrylate acid (EAA) or ethylene vinyl acid (EVA), among others, to ensure a correct watertightness between the core conductor and the dielectric. The dielectric consists of a cellular high expansion polymer, said high expansion polymer can be formed by a low density polyethylene or mixture of low, medium and high density polyethylene plus a swelling agent for controlling the swelling material that can be azodicarbonamide, p-toluene sulfonyl hydrazide, 5-phenyl tetrazol, among others. Between the dielectric and the second conductor, there can be or not a layer or film of polymer mixed with a certain proportion of adhesive such as ethylene acrylate acid (EAA) or ethylene vinyl acid (EVA), among others. The object of said second polyethylene film is to give watertightness to the swelling dielectric and to improve the surface appearance of the dielectric, and also to permit a better control of the dielectric swelling process. The second or external

conductor 15 can be formed by a tape made of aluminum alloy, copper alloy or any combination of said metals with others, formed in a tube that can be longitudinally welded, extruded or with overlapping edges. On said second conductor a water penetration protective element is placed, said protection consisting of one or several swellable fibers or tapes made of polyester threads or other fibers as basis for the swellable element applied helically, annularly or longitudinally. Finally, on the external conductor a protective cover is placed which can be of any type of polymer such as low density, medium density and high density polyethylene or any combination of them.

[0010] Figure 1 shows the dry coaxial cable 10 with the water penetration protection object of the instant invention. Said cable can be used as trunk or distribution cable in transmission networks for radio frequency signals, specifically for analog or digital television transmission signals as well as energy signals for activating control peripheral equipment. It can also be used for Internet signal transmission, data transmission, cellular phone, etc. Said cable is made of a solid or hollow core conductor 11 which must be manufactured with materials showing good electric conductivity, such as copper, aluminum or a combination of them. Said core can even consist of a steel part commercially known as copper plated steel or steel plated with other metal. Figure 1 shows a solid core conductor 11, because it is the most common type. Said core conductor is protected by a low dielectric coefficient polymer film 12 which can be polypropylene or polyethylene in order to have a maximum signal propagation and a minimum attenuation. Said polymer film 12 has to be as thin as possible to maintain the transmission characteristics, but its application onto the core conductor has to be continuous and homogeneous, because otherwise electrical problems will occur such as cable signal reflection. The main object of this film 12 is to protect the core conductor against corrosion and to control the adherence between the core conductor and the dielectric. It is thus possible to add a given amount of adhesive to the film polymer, said adhesive being ethylene acrylate acid (EAA) or ethylene vinyl acid (EVA), among others. The main insulation 13 is a cellular high expansion polymer made of low dielectric coefficient polymers such as polypropylene, polyethylene or polyester, said insulation 13 having a high cellular expansion in order to lower the dielectric constant through a reduction of the polymer mass per length unit. Preferably, low density polyethylene is used or a mixture of low, medium or high density polyethylene plus a swelling agent to control the swelling, which can be azodicarbonamide, p-toluene sulfonyl hydrazide, 5-phenyl tetrazol, among others. Between the dielectric 13 and the second conductor 15, there can be or no a layer or film 14 of any mixed polymer and it can be combined with a quantity of any adhesive such as ethylene acrylate acid (EAA) or ethylene vinyl acid (EVA), among others. Said second film 14 is formed of any low dielectric coefficient polymer such as polyethylene, having the object of giving water resistance to the swollen dielectric and improving the surface appearance of the dielectric, besides permitting a better control of the swelling process of the dielectric. This second conductor 15 covers the dielectric insulation and is constituted by a metal pipe formed around the dielectric, which can be welded longitudinally, extruded or with overlapping edges. Said second conductor 15 is made of conductive material such as aluminum, copper, or any combination of them, and can also be a braided mesh of metal wires made of copper, aluminum, or other metal alloys.

[0011] According to the invention, Figures 1 and 2 show the water penetration protective element 16 which is applied helically. However it can also be applied annularly or longitudinally on the second conductor. Said protective element consists of one or several swellable fibers or tapes formed by polyester threads or other fibers. As basis of the swellable element, polyacrylate fibers such as polyacrilamide, polyacrylic acid, among others, can be used.

[0012] The protective layer 17 shown in Figure 1 must perfectly cover the second conductor 15 having a smooth and uniform appearance. Said second conductor can contain or not one or several identification fringes of the same material but different color. Said protective cover 17 gives firmness to the cable and must be formed of a thermoplastic material resistant to temperature, fire and ultraviolet light, to extreme environmental conditions, to rodents, to cuts as well as to chemicals substances. It must also present good stress resistance, besides showing low fume emissions. The thermoplastic materials used can be low, medium or high density polyethylene or any combination of these or other types of thermoplastic elements.

[0013] Figure 3 shows a diagram of the way the core or insulation for the coaxial cable of the instant invention is manufactured. Figure 4 shows the diagram of the application process for the second conductor, the water penetration protective element and the protective cover, in both cases the description is given from left to right. First, Figure 3, there is the feeding reel 18 containing the core conductor 11. In order to give continuity to the process, the end of the conductor is coupled to the beginning of the conductor of the new reel through welding ensuring the absence of deformation and maintaining the requested diameter in order to conserve electrical as well as mechanical characteristics. The core conductor 11 passes then through the first polymer film applicator 19. Said film can be applied through extrusion, flooding the conductor in the insulating material and then removing the excess material or through sprinkling, as previously mentioned. This first film can be formed of polyethylene, polyester or polypropylene mixed in a given ratio with an adhesive which can be ethylene acrylate acid (EAA), among others.

[0014] The main insulating element 12 or dielectric is placed in the extrusion device 20 which can be a single extruder (simple) or two serial extruders which are known as cascade, to obtain high cellular expansion. Normally, high, low or medium density polyethylene is used, or any combination of them with a swelling control agent that can be azodicarabonamide, p-toluene sulfonyl hydrazide, phenyl tetrazol, among others, to reach high cellular expansion. Besides the above-

mentioned materials, a physical expansion can be generated injecting a high pressure inert gas in the extrusion process, the gas used being Nitrogen, Argon, Carbon Dioxide, among others or any combination of these. However, there also exists the chemical swelling which is conducted directly by the swelling agent as the above-mentioned azodicarbonamide. The second polymer film is optional and is applied on the equipment 27. Said second polymer film can be equal to the first film and applied through extrusion, flooding the conductor in the insulating element and then removing the excess or through sprinkling. If it is through extrusion, said film is applied through co-extrusion, i.e., there are two extruders, one for the main insulating element 13 and the other for the second polymer film 14. Said extruders are connected to a single extrusion head appropriately designed for this purpose, as previously mentioned, said second film consisting of polyethylene, polyester or polypropylene mixed in a given ratio with an adhesive which can be ethylene acrylate acid (EAA), among others. Other option to manufacture the core is through triple co-extrusion, in which there are three extruders, one for the first film 12 another for the main insulation material 13, and the other for the second film 14, connected to an extrusion head properly designed to obtain the core with the 3 above-mentioned interfaces.

[0015] Once the core or central insulation 11 is obtained, it must be cooled to prevent deformation when winding it, which is made in the cooling trough 22 and water at controlled temperature, air, vapor, or any combination of them can be used. Finally, the core is stored on a reel 23 to be sent to the following process.

[0016] The diagram in Figure 4 starts with the feeding reel 23 containing the core 11 onto which a pipe denominated second conductor 15 is placed. Said pipe can be made of aluminum, copper or any combination of them. According to the initial description of the product, there are three options for the application of the second conductor: welded tape, overlapped tape, or through extrusion. In the case of welded or overlapped tape conductor, Figure 4 shows the tape winding equipment 24 which receives the tape 25 in rolls and unwinds it to be introduced to the process. Said tape 25 is formed around the core 11 through the appropriate equipment 26, for example through forming rollers or dice. With regard to a welded second conductor 15, this welding process is conducted on the equipment 29 through a high frequency or Tig process.

[0017] After welding, the pipe is submitted to a trimming step in which burrs or welding process imperfections are eliminated giving a round and uniform pipe. Then, the core-external conductor complex passes through a diameter adjustment box which can contain 1 to 4 dice which reduce the pipe diameter to adjust and even compress the core 11 insuring a good contact and coverage of the core 11. During this process, a lubricant has to be used to prevent damage to the pipe and the dice. If the second conductor is applied through overlapping of the edges, it will go directly from the forming equipment 26 to the diameter adjustment box 28 where it will be adjusted to the core 11, being ready for the following process step. In this case, no lubricant is used.

[0018] If the second conductor 15 is applied through extrusion, the material used will be preferably an aluminum alloy and the process will include a device 29 for unwinding the wire rod 30 to be introduced to the process. Said wire rod 30 together with the core 11 penetrate into an appropriate extrusion device 31 in which the wire rod is extruded around the core, forming a pipe. Then, the core-external conductor complex passes through the diameter adjustment box 28 which can contain 1 to 4 dice which reduce the pipe diameter to adjust and even compress the core 11 insuring a good contact and coverage of the core 11. During this process, a lubricant has to be used to prevent damage to the pipe and the dice.

[0019] The cable 32 indicated in Figure 4 passes through the adequate device 33 for its application onto the second conductor 15 of the water penetration protective element 16 object of the instant invention. Said protective element consists of one or various swellable fibers or tapes made of polyester threads or other fibers as basis of the swellable element. Said fibers or tape are preferably applied helically, however they can also be applied annularly or longitudinally. Once the water penetration protective element 16 is applied, the cable passes through an extruder 34 where the protective cover 17 is applied. Said cover is formed of a resistant thermoplastic element which can be low, medium or high density polyethylene or any combination of them or other types of thermoplastic elements. If necessary one or several identification fringes made of the same material but of different colors, can be made through co-extrusion using the same extrusion head.

[0020] Once the cable 36 is obtained, it is protected by the cover and has to be cooled to prevent deformations when winding it, and this is conducted in a cooling trough 35 using water at controlled temperature. Finally the cable 36 is stored on a reel 37 to be stored, cut or shipped.

MATERIAL CHARACTERISTICS AND CABLE CONSTRUCTION

[0021] ➢ Internal Conductor (core)

[0022] The core conductor is made of copper plated aluminum wire, with a 3.15 ± 0.03 mm diameter; it also has a uniform round cross section, seamless and imperfection free, and meets the requirements of ASTM B 566 standard, Class 10A.

sorption speed of ≥ 15 ml/g per minute and their absorption capacity is over 30 ml/g.

8. The dry coaxial cable according to claim 1, **characterized in that** the external cover is preferably made of medium density black polyethylene and has a diameter on cover of 15.5 mm ± 0.10 mm with a 0.67 mm ± 0.02 mm thickness.

9. A manufacturing method for the dry coaxial cable according to claims 1 to 8, consisting of the following steps: preparing a core conductor feeding reel welding its end onto another reel so that the manufacturing can be continuous, passing the core conductor onto a first polyethylene film application through extrusion, the polymer being chosen among polyethylene, polyester or polypropylene mixed with an ethylene acrylate acid adhesive; extruding, based on high, low or medium density polyethylene mix with a swellable agent such as azodicarbonamide, p-toluene sulphonyl hydrazide or 5-phenyl tetrazol with high pressure inert gas injection to improve cellular expansion, optionally a second film having the same characteristics as the first one through co-extrusion; cooling at room temperature; the core obtained is wound and a pipe shaped external conductor made of aluminum, copper or a combination of them is applied, said pipe can be formed through welding, or overlapping of the edges or through extrusion; application of helical, annular or longitudinal water penetration protection element; and application of the protective cover through extrusion of low, medium or high density polyethylene or a combination of them.

10. The manufacturing method for the dry coaxial cable according to claim 9, **characterized in that** the core can be manufactured through triple co-extrusion in three extruders, one for the first film, another for the main insulation and the other for the second film, which are connected to an extrusion head.

Patentansprüche

1. Trockenes wasserbeständiges Koaxialkabel, bestehend aus: einem Metallkern-Leiterelement, einem dielektrischen Element um den Kernleiter herum basierend auf drei Schichten, wobei die erste Schicht auf den Leiter als gleichförmig dicker Film basierend auf Polyethylen mit niedriger Dichte gemischt mit einem Vinyl- oder Acryl-Klebstoff aufgetragen ist, die zweite Schicht auf Basis eines expandierten Polyethylen-Gemisches bestehend aus Polyethylen mit niedriger Dichte oder einem Gemisch aus Polyethylenen mit niedriger, mittlerer und hoher Dichte und einem Quellmittel basierend auf Azodicarbonamid, p-Toluol-Sulfonylhydrazid oder 5-Phenyl-Tetrazol sowie optional einer Verstärkungsschicht mit denselben Eigenschaften wie die erste Schicht gebildet ist, **dadurch gekennzeichnet, dass** es ein zweites äußeres Leiterelement besitzt, das aus einem Band aus Aluminium oder einer Kupferlegierung oder kombiniert mit anderen Elementen gebildet ist und den Leiter umgibt, bestehend aus einem Wassereintritt-Schutzelement, das es trocken hält und auf Basis einer oder mehrerer quellfähiger Fasern oder Bändern gebildet ist, die durch Polyester-Fäden oder andere quellbare Fasern gebildet sind, und wobei die Schutzabdeckung auf Basis von Polyethylen niedriger, mittlerer oder hoher Dichte oder einer Kombination daraus gebildet ist.

2. Trockenes Koaxialkabel nach Anspruch 1, **dadurch gekennzeichnet, dass** der Kernleiter ein kupferbeschichteter Aluminiumdraht ist und einen gleichförmigen kreisförmigen Querschnitt von 3,15 ± 0,03 mm Durchmesser hat.

3. Trockenes Koaxialkabel nach Anspruch 1, **dadurch gekennzeichnet, dass** die Klebstoff-Komponente ausgewählt ist zwischen Ethylenacrylat-Säure oder Ethylenvinyl-Säure, die eine bessere Haftung und Wasserbeständigkeit zwischen dem Kernleiter und dem dielektrischen Element ermöglichen.

4. Trockenes Koaxialkabel nach Anspruch 1, **dadurch gekennzeichnet, dass** der auf den Kernleiter aufgetragene zweite Polyethylen-Film eine bessere Wasserdichtigkeit gegenüber dem quellbaren Dielektrikum aufweist, sein oberflächliches Erscheinungsbild verbessert und einen Durchmesser von 13,0 ± 0,10 mm aufweist.

5. Trockenes Koaxialkabel nach Anspruch 1, **dadurch gekennzeichnet, dass** der aus einem Band aus Aluminium oder einer Kupferlegierung oder einem Gemisch davon bestehende äußere Leiter in einem zylinderförmigen Rohr gebildet ist und in Längsrichtung verschweißt, extrudiert oder mit seinen Kanten überlappt werden kann, und eine Dicke von 0,34 mm hat, wobei der Durchmesser auf dem Rohr 13,70 mm ± 0,10 mm beträgt.

6. Trockenes Koaxialkabel nach Anspruch 1, **dadurch gekennzeichnet, dass** das Wassereintritt-Schutzelement aus quellbaren Bändern besteht, die schraubenförmig, ringförmig oder in Längsrichtung angebracht sind.

7. Trockenes Koaxialkabel nach Anspruch 6, **dadurch gekennzeichnet, dass** die Feuchtigkeit-Schutzelemente eine Absorptionsgeschwindigkeit von ≥ 15 ml/g pro Minute haben und ihre Absorptionsgeschwindigkeit über 30 ml/g liegt.

8. Trockenes Koaxialkabel nach Anspruch 1, **dadurch gekennzeichnet, dass** die äußere Abdeckung vorzugsweise aus schwarzem Polyethylen mittlerer Dichte besteht und einen Durchmesser auf der Abdeckung von 15,5 mm ± 0,10 mm mit einer Dicke von 0,67 mm ± 0,02 mm hat.

9. Herstellungsverfahren für das trockene Koaxialkabel nach Anspruch 1 bis 8, bestehend aus den folgenden Schritten: Vorbereiten einer Kernleiter-Zufuhrwicklung und Anschweißen ihres Endes an eine andere Wicklung, so dass die Herstellung kontinuierlich erfolgen kann; Weiterführen des Kernleiters zu einer ersten Polyethylen-Filmauftragung durch Extrusion, wobei das Polymer aus Polyethylen, Polyester oder einem Polypropylen im Gemisch mit einem Ethylenacrylat-Säure Klebstoff ausgewählt wird; optionales Extrudieren eines zweiten Films mit denselben Kenngrößen wie der erste Film durch Co-Extrusion auf der Basis eines Gemischs von Polyethylen niedriger, mittlerer oder hoher Dichte mit einem Quellmittel wie Azodicarbonamid, p-Toluol-Sulfonylhydrazid oder 5-Phenyltetrazol und mit Hochdruck-Inertgas-Einleitung zur Verbesserung der Zellexpansion; Kühlen bei Raumtemperatur; wobei der gewonnene Kern gewickelt wird und ein rohrförmiger äußerer Leiter aus Aluminium, Kupfer oder einer Kombination daraus aufgetragen wird, wobei das Rohr durch Schweißen oder Überlappen der Ränder oder durch Extrusion gebildet werden kann; Auftragen eines schraubenförmigen, ringförmigen oder längsförmigen Wassereintritt-Schutzelements; und Auftragen der Schutzabdeckung durch Extrusion von Polyethylen niedriger, mittlerer oder hoher Dichte oder einer Kombination davon.

10. Herstellungsverfahren für das trockene Koaxialkabel nach Anspruch 9, **dadurch gekennzeichnet, dass** der Kern durch Dreifach-Coextrusion in drei Extrudern hergestellt werden kann, wovon einer für den ersten Film, ein anderer für die Hauptisolierung und ein weiterer für den zweiten Film bestimmt ist, und die mittels eines Extrusionskopfes verbunden sind,

Revendications

1. Câble coaxial sec résistant à l'eau, constitué de : un élément conducteur d'âme en métal, un élément diélectrique autour du conducteur d'âme basé sur trois couches, la première couche étant appliquée sur le conducteur sous la forme d'un film d'épaisseur uniforme basé sur un polyéthylène basse densité mélangé à un adhésif vinylique ou acrylique, la deuxième couche étant basée sur un mélange de polyéthylène expansé consistant en du polyéthylène basse densité ou un mélange de polyéthylènes basse, moyenne et haute densité et un agent gonflant basé sur l'azodicarbonamide, le p-toluène sulphonyle hydrazide ou le 5-phényle tétrazol, et en option une couche de renforcement ayant les mêmes caractéristiques que la première couche ; **caractérisé en ce qu'**il possède un deuxième élément conducteur externe formé d'une bande constituée d'un alliage d'aluminium ou de cuivre ou combiné à d'autres éléments et entourant ledit conducteur, constitué d'un élément protecteur contre la pénétration d'eau qui le maintient sec et est basé sur une ou plusieurs fibres ou bandes gonflantes formées de fils de polyester ou d'autres fibres gonflantes ; et la couverture protectrice est basée sur du polyéthylène basse, moyenne ou haute densité ou sur une combinaison de ceux-ci.

2. Câble coaxial sec selon la revendication 1, **caractérisé en ce que** le conducteur d'âme est un film d'aluminium plaqué de cuivre, d'une section circulaire uniforme de 3,15 ± 0,03 mm de diamètre.

3. Câble coaxial sec selon la revendication 1, **caractérisé en ce que** le composant adhésif est choisi entre l'acide d'éthylène acrylate ou l'acide d'éthylène vinyle, permettant une meilleure adhérence et une meilleure résistance à l'eau entre le conducteur d'âme et l'élément diélectrique.

4. Câble coaxial sec selon la revendication 1, **caractérisé en ce que** le deuxième film de polyéthylène appliqué sur le conducteur d'âme présente une meilleure imperméabilité à l'eau que le diélectrique gonflant, améliore son aspect de surface et présente un diamètre de 13,0 ± 0,10 mm.

5. Câble coaxial sec selon la revendication 1, **caractérisé en ce que** le conducteur extérieur formé d'une bande constituée d'un alliage d'aluminium ou de cuivre ou d'un mélange de ceux-ci est formé en un tuyau cylindrique et peut être soudé longitudinalement, extrudé, ou ses bords peuvent se chevaucher, et il présente une épaisseur de 0,34 mm et le diamètre du tuyau est de 13,70 mm ± 0,10 mm.

6. Câble coaxial sec selon la revendication 1, **caractérisé en ce que** l'élément protecteur contre la pénétration de l'eau consiste en des bandes gonflantes placées en hélice, de façon annulaire ou longitudinalement.

7. Câble coaxial sec selon la revendication 6, **caractérisé en ce que** les éléments de protection contre l'humidité présente une vitesse d'absorption de ≥ 15 ml/g par minute et leur capacité d'absorption est supérieure à 30 ml/g.

8. Câble coaxial sec selon la revendication 1, **caractérisé en ce que** la couverture extérieure est de préférence constituée de polyéthylène noir moyenne densité et a un diamètre sur la couverture de 15,5 mm ± 0,10 mm avec une épaisseur de 0,67 mm ± 0,02 mm.

9. *Procédé de fabrication du câble coaxial sec selon l'une des revendications 1 à 8, consistant en les étapes suivantes :* préparation d'une bobine d'alimentation en conducteur d'âme en soudant son extrémité sur une autre bobine, de sorte que la fabrication peut être continue, passage du conducteur d'âme sur une première application de film de polyéthylène par extrusion, le polymère étant choisi parmi le polyéthylène, le polyester ou le polypropylène mélangé à un adhésif à l'acide d'éthylène acrylate ; extrusion, à partir d'un mélange de polyéthylène haute, basse ou moyenne densité avec un agent gonflant tel que l'azodicarbonamide, le p-toluène sulphonyle hydrazide ou le 5-phényle tétrazol avec une injection de gaz inerte à haute pression pour améliorer l'expansion cellulaire, en option d'un deuxième film ayant les mêmes caractéristiques que le premier par co-extrusion ; refroidissement à la température ambiante; l'âme obtenue est enroulée et un conducteur extérieur en forme de tuyau composé d'aluminium, de cuivre ou d'une combinaison des deux est appliqué, ledit tuyau peut être formé par soudage, ou chevauchement de ses bords ou par extrusion ; application d'un élément hélicoïdal, annulaire ou longitudinal de protection contre la pénétration de l'eau et application de la couverture protectrice par extrusion de polyéthylène basse, moyenne ou haute densité ou d'une combinaison de ceux-ci.

10. Procédé de fabrication du câble coaxial sec selon la revendication 9, **caractérisé en ce que** l'âme peut être fabriquée par une triple co-extrusion dans trois extrudeuses, une pour le premier film, une autre pour l'isolation principale et l'autre pour le deuxième film, qui sont reliées à une tête d'extrusion.

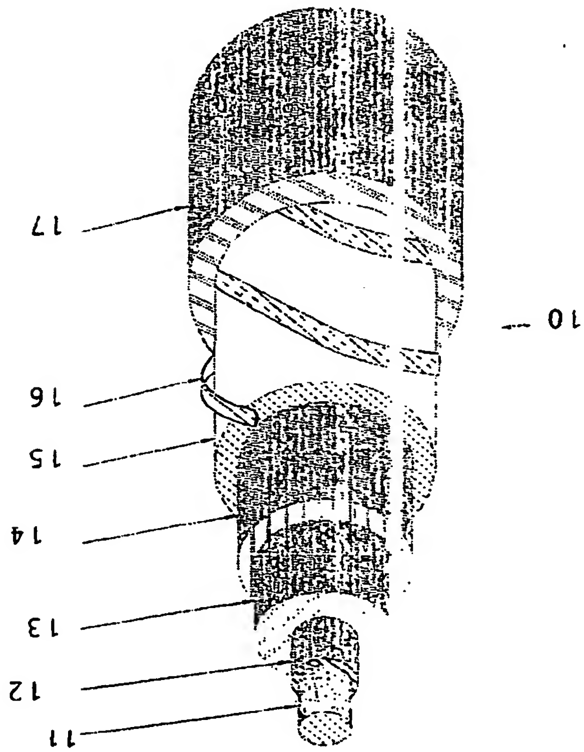


FIG. 1

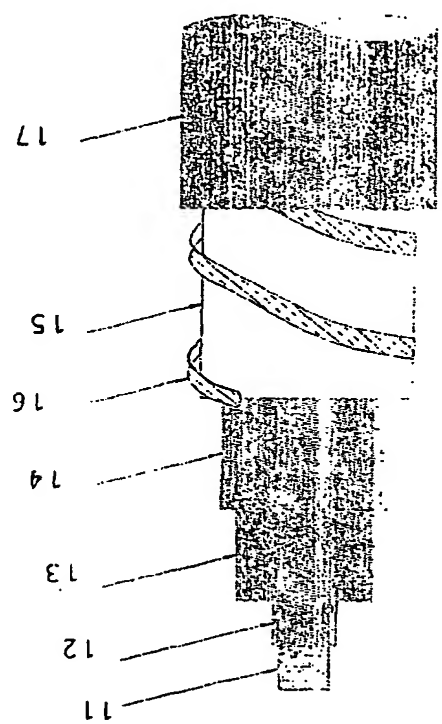
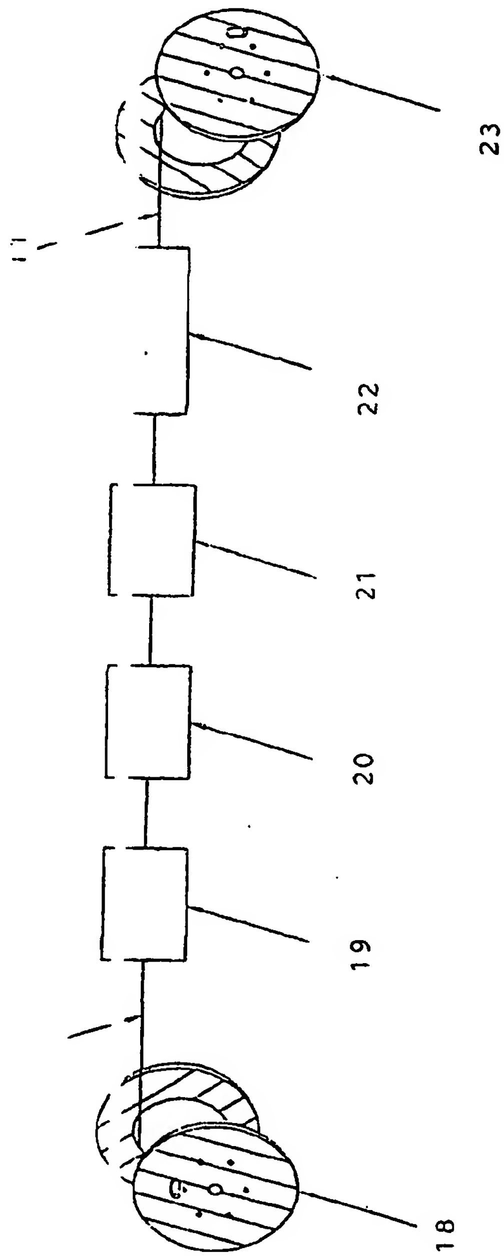


FIG. 2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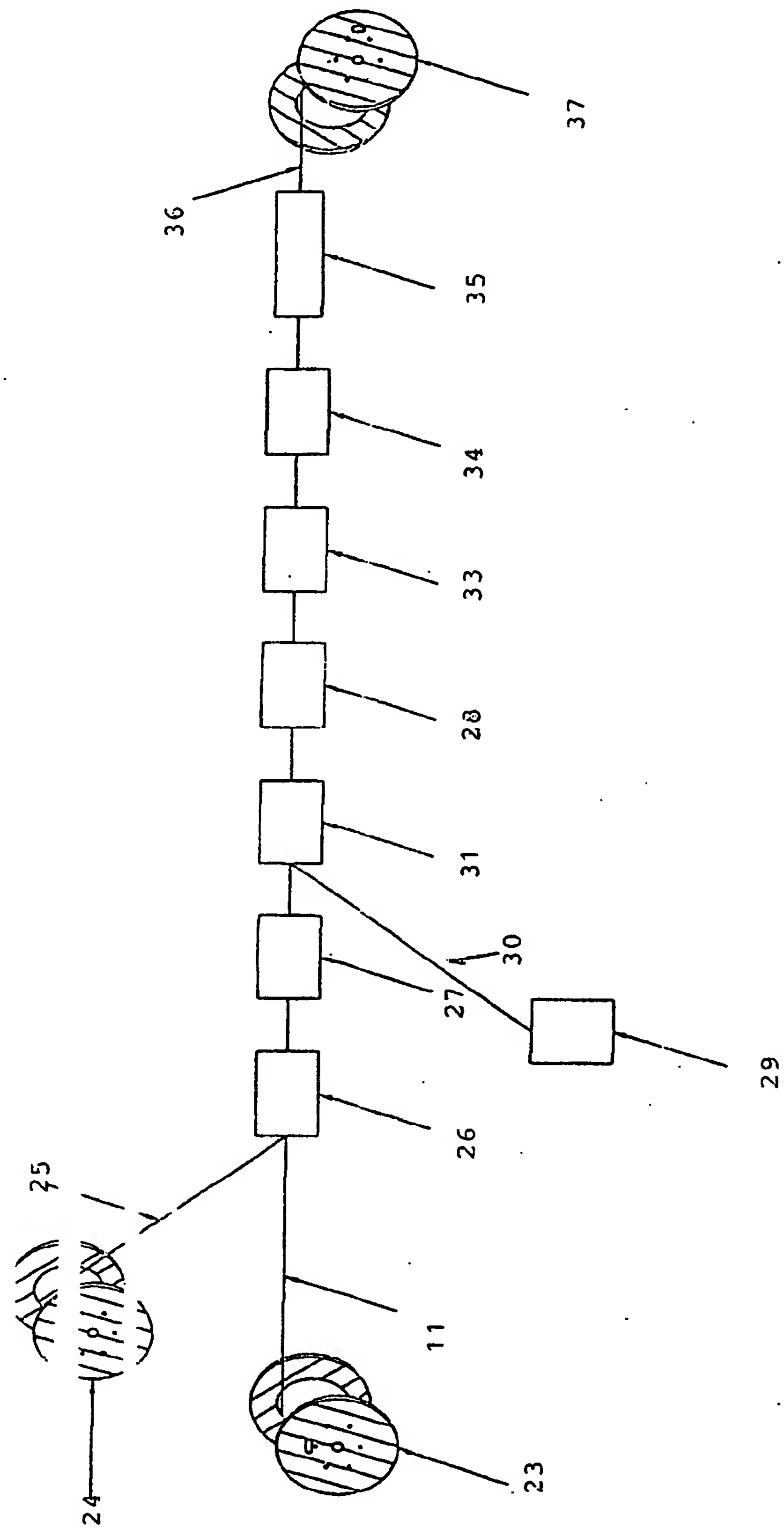
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(71) Applicant: Servicios Condumex S.A. De C.V.
C.P. 76120 Queretaro, QRO (MX)

(72) Inventors:
- Yanez Martinez, Leonel
C.P 76120 Queretaro, Qro (MX)
- Osornio Osornio, Victor
C.P 76120 Queretaro, Qro (MX)
- Rodriguez Camacho, Raul
C.P 76120 Queretaro, Qro (MX)

(74) Representative: Watkins, Rosalind Philippa
Swindell & Pearson
48 Friar Gate
Derby DE1 1GY (GB)

(54) Dry water-resistant coaxial cable and manufacturing method of the same

(57) Dry coaxial cable resistant to water penetration, made of a core conductor, a dielectric element based on three layers of polymers, and an external conductor and an extruded cover, characterized because it has swellable protecting elements against water penetration placed between the external conductor and the protective cover.

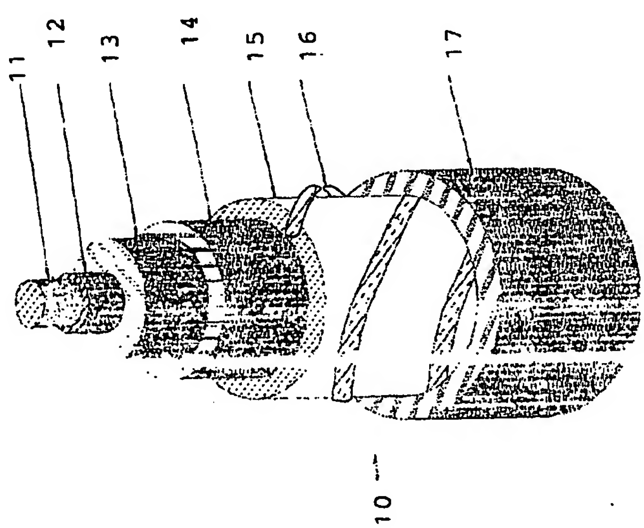

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 25 4294

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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			H01B

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	26 October 2005	Demolder, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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EPO FORM 1503 03.82 (P04C01)

➢ Dielectric

[0023] The dielectric consists of three layers. The first layer, the conductor, is a uniformly thick film made of low density polyethylene mixed with adhesive. Said layer links the conductor to the dielectric and acts as a moisture blocking element and minimizes the presence of air bubbles that contribute to the instability of the characteristic impedance and the structural return losses (SRL). The second layer of the dielectric is a polyethylene mix physically expanded through gas injection. The materials used have to be virgin. Recycled or reprocessed materials shall not be used. The dielectric is to be applied concentrically on the conductor, adhering onto it, and shall have a 13.0 ± 0.10 mm diameter. The third layer has the same properties as the first layer and ensures the surface uniformity of the intermediate layer and enhances the adherence of the aluminum pipe onto the dielectric. The polyethylene mix used in the dielectric shall fulfill the requirements of standard ASTM D 1248 Type I, III and IV, Class A, category 3.

➢ External Conductor

[0024] The external conductor is a cylindrical pipe made of aluminum alloy 1350, and shall meet the requirements of ASTM B 233. The thickness of the pipe shall be 0.34 mm and its diameter shall be 13.70 mm ± 0.10 mm.

➢ Water blocking threads

[0025] The external conductor is helically surrounded with a pair of water blocking threads. Said threads have an absorption speed ≥ 15 ml/g per minute and their absorption capacities is about 30 ml/g.

➢ External cover

[0026] The external cover is made of medium density black polyethylene, adding the precise ratios of antioxidant and carbon black to ensure the best conditions against weathering, including protection against UV rays.
[0027] The surface of the cover shall be free of holes, cracks and any other defect.
[0028] The cover diameter shall be 15.5 mm ± 0.10 mm, with a 0.67 mm ± 0.02 mm thickness.
[0029] The polyethylene used for the cover shall meet the following characteristics:

Characteristic	Value	Test method
Density (g/cm^3)	0.900 - 0.955	ASTM D 1505
Minimum elongation (%)	400	ASTM D 638
Minimum elongation Retention (%)	75	ASTMD 573 After 48 hours at 100 °C
Carbon Black Contents (%)	2.35 - 2.85	ASTM D 1603

Physical Tests:

Cable bending test

[0030] The complete cable must fulfill all the requirements established in standard EN 50117, Clause 10.2 for the bending test.

Cable tensile stress test

[0031] The cable shall withstand a maximum tensile stress of 980 N, without presenting changes in the electrical characteristics specified in this document. Besides, the cable shall not present cracks or ruptures in the insulation, in the metal elements or in the cover, after having been submitted to the tests described in standard EN 50117, Clause 10.3.

Compressive strength test

[0032] The cable must pass the compressive strength test conducted according to standard EN 50117, Clause 10.4. After a maximum recovery time of 5 minutes, the maximum irregularity will be below 1%.

Insulation longitudinal contraction test

[0033] *Samples of insulated conductor shall be submitted to contraction test according to the procedures specified in* ASTM D 4565. The total contraction of the insulation shall not be over 6.4 mm.

Cover longitudinal contraction test

[0034] The cable cover shall be tested to measure its longitudinal contraction, following the procedure established in standard SCTE IPS-TP-003. The contraction shall not be above 9.52 mm in a 152 mm long sample.

Test of adherence between the core conductor and the insulation

[0035] The core conductor shall adhere onto the dielectric material insulating the cable. Said adherence shall be strong enough to prevent sliding between the two elements, but must also allow the separation of said two elements during cable preparation for connection. The test shall be conducted according to standard EN 50117, Clause 10.1.

Weathering test

[0036] The finished cable shall be submitted to the weathering test according to the procedures established in standard EN 50117, Clause 10.6. This test is conducted in order to determine the capacity of the cable to maintain its electrical characteristics and the cover integrity in case of weather changes.

Electrical Characteristics of the finished product

[0037] The cable shall present the following electrical characteristics when they are evaluated according to standard EN 50117-1:

Core conductor DC resistance @ 20 °C	**3.34 Ω/km**
External conductor DC resistance @ 20 °C	**1.94 Ω/km**
Minimum electrical resistance of the insulation	**10 ^{4}MΩ/km**
Capacitance @ 1KHz	**50.00 ± 3.0 pF/km**
Characteristic impedance @ 1 ≥f≤ 1000;f(MHz)	**75.00 ± 2.0 Ω**
Propagation speed	**88 %**

Attenuation @ 20°C

Frequency (MHz)	**DB/100 m**
5	**0.46**
30	**1.12**
55	**1.53**
108	**2.16**
150	**2.57**
211	**3.12**
250	**3.38**
300	**3.71**
350	**4.02**
400	**4.31**
450	**4.57**
500	**4.88**
550	**5.12**
600	**5.31**
750	**6.07**
800	**6.28**
862	**6.56**

(continued)

Attenuation @ 20°C	
Frequency (MHz)	DB/100 m
900	6.85
950	6.93
1000	7.12
Return losses @	20 °C
Frequency (MHz)	dB
5 - 1000	≥ 30

Mechanical characteristics of the product

[0038] The cable shall present the following mechanical characteristics tested according to standard EN50117-1:

Maximum stress without change in electrical properties	**980 N**
Minimum bending radio	**102 mm**
Adherence onto the dielectric	***≥ 1.3 Mpa***

[0039] The cable shall be designed to operate at temperatures between -40 to 80 °C and shall present a nominal net weight of 140 Kg/Km.

Claims

1. Dry water resistant coaxial cable consisting of: a metal core conductor element, a dielectric element around the core conductor based on three layers, the first layer being applied onto the conductor as a uniformly thick film based on low density polyethylene mixed with a vinyl or acrylic adhesive, the second layer being based on an expanded polyethylene mix consisting of low density polyethylene or mixture of low, medium, and high density polyethylenes and a swelling agent based on azodicarbonamide, p-toluene sulphonyl hydrazide, or 5-phenyl tetrazol, and optionally a reinforcement layer of the same characteristics as the first one; **characterized in that** it has a second external conductor element formed by a tape made of an aluminum, or copper alloy or combined with others elements and surrounding said conductor, consisting of a water penetration protective element keeping it dry and based on one or several swellable fibers or tapes formed by polyester threads or other swellable fibers; and the protective cover based on low, medium, or high density polyethylene or a combination of them.

2. The dry coaxial cable according to claim 1, **characterized in that** the core conductor is copper plated aluminum wire, with a uniform circular cross section of 3.15 ± 0.03 mm diameter.

3. The dry coaxial cable according to claim 1, **characterized in that** the adhesive component is chosen between ethylene acrylate acid or ethylene vinyl acid permitting a better adherence and water resistance between the core conductor and the dielectric element.

4. The dry coaxial cable according to claim 1, **characterized in that** the second polyethylene film applied onto the core conductor, shows a better watertightness to the swellable dielectric, improves its superficial appearance and offers a 13.0 ± 0.10 mm diameter.

5. The dry coaxial cable according to claim 1, **characterized in that** the external conductor formed by a tape made of aluminum or copper alloy or mixture of them is formed in a cylindrical pipe and can be longitudinally welded, extruded or the edges can be overlapped and it has a thickness of 0.34 mm and the diameter on the pipe is 13.70 mm ± 0.10 mm.

6. The dry coaxial cable according to claim 1, **characterized in that** the water penetration protective element consists of swellable tapes placed helically, annularly or longitudinally.

7. The dry coaxial cable according to claim 6, **characterized in that** the moisture protection elements have an ab-

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 25 4294

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82